SYSTRON DONNER

A THORN EMI company

CHAPTER 1. 19XXB

GENERAL INFORMATION

1-1. INTRODUCTION

1-1.1 This instruction manual contains information relating to Specifications, Installation, Operation, Theory of Operation, Maintenance and Calibration of the Systron Donner Model 19XXB Series Microwave Sweep Generator.

1-1.2 The information contained in this instruction manual is divided into front matter and seven descriptive chapters, indicated in the following format:

Front Matter: includes the title page, proprietary rights statement, list of effective pages, table of contents, list of tables, and list of figures.

Chapter 1 - General Information: contains a general description of the Model 1900 Series Sweep Generator including specifications, options and accessories.

Chapter 2 - Installation: describes unpacking and inspection, installation criteria initial turn-on/confidence checks, IEEE Std 488 GPIB system interconnection, and preparation for reshipment.

Chapter 3 - Operation: provides descriptions of front- and rear-panel controls, indicators and connectors located on the 19XX Sweeper. It also includes instrument operating procedures, supplemented by IEEE 488 GPIB programming characteristics.

Chapter 4 - Theory of Operation: contains a detailed functional/circuit description of the 1900B series Sweeper which will assist technical personnel in the performance of troubleshooting and/or calibration procedures.

Chapter 5 - Maintenance: describes the steps required for routine maintenance, inspection, alignment, and performance verification.

Chapter 6 - Replaceable Parts: are listed in this chapter, along with parts ordering information, and manufacturer's code-to-name index.

Chapter 7 - Drawings: provides technical personnel with requisite schematic and component locator diagrams, assembly drawings for maintenance and troubleshooting of the 1900B series Sweeper.

1-2. EFFECTIVITY OF MANUAL

1-2.1 The Model 1900B Series Operating and Service manual is a revision/configuration-controlled document. Information contained in this manual is code-dated, at the bottom of each page, showing the manual effectivity. A summary of these code dates is given in the list of effective pages provided in the front matter of this manual. Instrument changes, which occur after the release of this manual, will be documented by change supplements to be inserted into the front of future publications. Change supplement information may also include the correction of errors which were not yet determined at the date of this publication. Any future changes to this manual will be reflected in the code-date on the bottom of the changed pages and on the List of Effective Pages.

1-3. DESCRIPTION

1-3.1 Systron Donner's 1900B Series of sweep generators provide sophisticated, economical solutions for both production and R&D testing applications. Swept output frequency capability and synthesizer accuracy are featured in five programmable single-band instruments covering standard bands from 2 to 26.5 GHz. For straddle-band applications, the 1910B covers 2 to 8 GHz. Custom frequency ranges are available for special applications.

1-3.2 Housed in a standard 5.25" half-rack package, the 1900B Series features a single-YIG architecture that provides the desired frequency range without the cost associated with driving additional oscillators. Full-function,. sophisticated features make these sweepers extremely versatile. Resolution for all frequency parameters is 1 MHz. All models have Start-Stop, Center-Delta, and external sweep capability as well as CW output. The sweep may be triggered automatically, manually, externally or via the AC line.The RF signal may be amplitude and frequency modulated by external signal sources. Five fully independent marker frequencies are available. Additional functions include a voltage proportional to the output frequency; penlift and blanking signals; a buffered ramp output; and input which permits a temporary sweep halt on command.

1-3.3 User choice leveling. The output may be controlled manually or with external leveling. Internal leveling is optional on all models. When the necessary leveling components are already available to the user, internal leveling is not required. External leveling is also more accurate in situations where the device under test is more than a few inches from the sweeper.

1-3.4 Thermal modeling and conservative design practices have resulted in a reliable sweeper designed to meet or exceed MIL-T-28800 for Type 3, Class 5 instruments. Even at 26 GHz the internal temperature rise is less than 5 degrees C when 33.5 cfm of air is available for the cooling fan. Worse case rise is less than 10 degrees C even if the fan fails or the ambient exceeds the maximum operating temperature.

1-3.5 Synthesizer accuracy in a full sweep generator. CW frequency is effectively that of a synthesizer. CW frequencies can be phase locked with a resolution of 100 MHz. The spectral purity of the RF output often exceeds that of the finest synthesizers. Single sideband phase noise at an offset of 100 kHz is typically below 90 dBc.

1-3.6 Easy-to-use remote control interface. The optional IEEE-488 interface permits remote control of all instrument functions except AC power on-off switching. To speed the development of control software, the interface responds to a native language using English words which correspond to the front panel controls. An alternate command set is provided to permit more compact programming, and keywords from each set may be mixed as desired. Additional features include the Local Lockout and Talk Only functions.

1-4. SPECIFICATIONS

1-4.1 The specifications for the 1900B Series Microwave Sweep Generator are listed in Table 1-1. Any acceptance test or calibration procedure will use these specifications as a tolerance guide. Also, Table 1-1 lists the standard options available for the Sweeper

Table 1-1 Specifications

PRIMARY SPECIFICATIONS. 0°C to +50°C unless stated otherwise.

Model Number	Frequency Range, GHz	Over-Range GHz, Typ.	Accuracy (+15°C to +35°C) CW, MHz	Sweep, MHz
1904B	2.0- 4.0	1.9- 4.1	± 10.0	± 35.0
1908B	4.0- 8.0	3.9- 8.1	± 15.0	± 45.0
1910B	2.0- 8.0	1.9- 8.1	± 25.0	± 60.0
1912B	8.0-12.0	7.9-12.1	± 30.0	± 60.0
1918B	12.0-18.0	11.9-18.1	± 40.0	± 80.0
1926B	18.0-26.5	17.8-26.8	± 75.0	±125.0

ACCURACY:

Frequency Accuracy is the relationship between setpoint and output frequencies; this parameter includes the effects of linearity, hysteresis, temperature, and load phase angle.

Sweep Accuracy applies to internal sweeps with durations of 100 mS or more.

Frequency Accuracy, Locked applies only to models with Phaselock. Short term, +15°C to +35°C, not worse than $1x10^{-6}$.

Frequency Resolution:

Phaselock Frequencies	100 MHz.
CW Frequencies	1 MHz.
Sweep Frequencies	1 MHz.
Marker Frequencies	1 MHz.

Frequency Stability, Unlocked:

Stability vs. Temperature is the maximum change in output frequency per degree C.

Stability vs. Time is measured over a 10-minute period which begins 60 minutes after selection of a new frequency, all other conditions held constant. Typically, for very long periods at the same frequency, this is equal to the instrument's residual FM.

Stability vs. AC Line is the maximum short-term change in frequency with changes in the AC line voltage, other conditions held constant, and includes effects of any internal temperature changes in the instrument.

Table 1-1 Specifications - Continued

Model Number	vs. Temp MHz/°C	vs. Time MHz	vs. Line MHz
1904B	± 0.4	± 0.2	± 0.4
1908B	± 0.8	± 0.2	± 0.8
1910B	± 1.0	± 0.2	± 1.5
1912B	± 1.2	± 0.5	± 1.2
1918B	± 1.8	± 1.0	± 1.8
1926B	± 2.6	± 2.5	± 2.6

Spectral Purity:

These parameters are measured at a setpoint level of +5.0 dBm.

Harmonics specifications apply separately to each individual harmonic. Non-harmonics exclude residual AM and FM modulation.

Phase noise applies only to the phase-locked mode and is measured in a 1 Hz bandwidth at an offset of 100 kHz from a carrier at the multiple of 100 MHz equal to or just below the highest specified frequency (the worst-case condition).

Residual FM is defined as the peak frequency deviation of the CW signal, in a 20 Hz to 20 kHz bandwidth. Measured by an HP8902A in tracking mode at the IF port of a spectrum analyzer connected to instrument's RF output.

Model Number	Harmonic	Non-Harmonic	Phase Noise	Residual FM
1904B	-40 dBc	-50 dBc	-74 dBc	18 kHz
1908B	-40 dBc	-50 dBc	-74 dBc	18 kHz
1910B	-40 dBc	-50 dBc	-74 dBc	15 kHz
1912B	-50 dBc	-50 dBc	-74 dBc	25 kHz
1918B	-50 dBc	-50 dBc	N/A	40 kHz
1926B	-50 dBc	-50 dBc	N/A	60 kHz

Maximum Available RF Output:

Guaranteed Output Power ≥+5.0 dBm, 0°C to +50°C.

RF Output Level: Range and Resolution.

Guaranteed -15.0 dBm to +5.0 dBm.
(+13 dBm typical to +35°C)

Table 1-1 Specifications - Continued

Resolution (MLA mode): Not specified.

Resolution (ALC modes):

Keys, IEEE Interface	0.1 dB and 1.0 dB.
Spinwheel	0.05 dB and 1.0 dB.

RF Level Display: Range and Resolution.

Range (MLA mode)	Not specified.
Range (ALC modes)	-19.9 to +19.9 dBm.
Resolution	0.1 dB.

RF LEVEL ACCURACY.

The relationship between the actual RF output and the level setpoint (visual or by IEEE interface). Includes level flatness, applies only to the internal ALC mode, and excludes overshoot due to RF muting during retrace. Applies over the specified frequency range at setpoints from +5.0 dBm to -15.0 dBm.

All except 1926B	±1.5 dB, 0°C to +50°C.
1926B <26 GHz	±3.0 dB, +15°C to +35°C.
1926B ≥26 GHz	±5.0 dB, +15°C to +35°C.

RF LEVEL FLATNESS.

RF level variation of the fundamental, excluding any perturbations due to RF muting during retrace. Measured in the internal ALC mode over the specified frequency range at a setpoint of +5.0 dBm and at any constant temperature from +15°C to +35°C. Excludes overshoot due to RF muting during retrace.

Model Number	Typical dB PP	Maximum dB PP
1904B	0.3	1.0
1908B	0.4	1.2
1910B	0.6	1.5
1912B	0.6	1.8
1918B	0.9	2.0
1926B <26 GHz	1.5	3.0
1926B >26 GHz	2.0	5.0

Table 1-1 Specifications - Continued

SWEEP CHARACTERISTICS.

Sweep Types:	Internal, External
Sweep Modes:	Start-Stop and Center-Delta.
Trigger Types:	Automatic (recurrent), Manual, AC line, and external.
Sweep Time Range:	<0.020 seconds to >20.000 seconds; 0.010 seconds nominal minimum.
Sweep Time Resolution:	0.005 seconds.
Sweep Time Accuracy:	Typically ±0.12% at 25°C.

Marker Characteristics.

Number of Markers:	5, individually settable anywhere within instrument range.
Minimum Separation:	The larger of; twice the Marker Accuracy specification or the span of frequencies covered in a 2 millisecond period.
Marker Output Pulse:	See data for Marker Output (J4).
Marker Accuracy:	The error between the marker setpoint and nominal RF frequencies at the start of the marker pulse. Valid for sweep times of 50 milliseconds or more.

Model Number	Accuracy MHz
1904B	±10
1908B	±10
1910B	±15
1912B	±15
1918B	±25
1926B	±40

Usable Range:	An individual marker may not operate if placed closer than the marker accuracy specification value to a sweep endpoint.

Table 1-1 Specifications - Continued

ADDITIONAL INPUTS AND OUTPUTS.	
External ALC Input:	Permits remote leveling of the sweeper's RF output with an external detector.
Required Input Polarity:	Negative.
Input Impedance:	2 kΩ (nominal).
Coupling Factor Range:	-10 dB to -16 dB.
External Trigger Input:	Permits external triggering of an internal sweep.
Trigger Slope:	Selectable positive or negative.
Input LO voltage:	CMOS/HC/TTL compatible.
Input HI voltage:	CMOS/HC compatible; and TTL with pullup.
Input Impedance:	10 kΩ (nominal) to +5V.
V(f) Output (rear panel J1):	Provides an output voltage proportional to the output frequency exclusive of any FM modulation.
Minimum Load:	1.0 kΩ, ground-referred.
Output (1926-B):	
Scaling:	+0.500 V/GHz.
Accuracy:	±0.1% ±0.0035 V, with a 2K load.
Output (other units):	
Scaling:	+1.000 V/GHz.
Accuracy:	±0.2% ±0.0035 V, with a 2K load.
Ramp Output (rear panel J2):	In the internal sweep mode, provides a positive-going linear analog ramp synchronous with and proportional to the completed portion of an internal sweep. In external sweep mode, provides a buffered representation of the applied external signal.

Table 1-1 Specifications - Continued

Minimum Load:	1.0 kΩ, ground-referred.
Output Voltage:	0.00 V to +10.00 V with a 2K load.
Ramp Input (rear panel J3):	Permits use of an external positive signal to control the swept frequency. User must guarantee 10 mS retrace time for ramps.
Input Impedance:	47 kΩ minimum.
Maximum Input Range:	-0.1 V to +10.1 V.
Maximum Input Slew Rate:	±1.0 V per millisecond.
Marker Output (rear panel J4):	Produces a pulse upon coincidence of the output frequency with an active marker during an internal sweep. User-selectable voltage or logic pulse.
Pulse Polarity:	Negative.
Pulse Width (nominal):	1.0 millisecond.
Voltage Pulse (nominal):	
Positive Limit:	0.0 V or +4.5 V.
Negative Limit:	-4.5 V or -13.5 V.
Output Impedance:	1 kΩ to positive limit 100 Ω to negative limit.
Logic Pulse:	CMOS/HC/TTL compatible.
Output LO:	Sink 4 mA.
Output HI:	Source 4 mA.
Sweep Halt Input (rear panel J5):	Used to halt an ongoing internal sweep or prevent initiation of an internal sweep.
Frequency Drift (halt):	Typically <1 MHz/second at +25 C.
Input Pulse Width:	1 mS minimum, unlimited maximum.

Table 1-1 Specifications - Continued

Input Voltages:	≤ +0.6 V to sweep ≥ +4.5 V to halt.
Maximum Input:	±15 V.
Input Impedance (nominal):	
Sweeping:	12 kΩ to ground.
Halted:	6 kΩ to ground.
NZ Blanking Output (rear panel J6):	Pulse is coincident with internal sweep retrace period.
User-selectable voltage limits.	
Pulse Polarity:	Negative.
Pulse Width:	9.4 millisecond (nominal).
Positive Limit:	0.0 V or +4.5 V (nominal).
Negative Limit:	-4.5 V or -13.5 V (nominal).
Output Impedance:	1 kΩ to positive limit (nominal) 100 ohms to negative limit (nominal).
AM Modulation Input (rear panel J7):	Specifications apply only when internal ALC is used.
RF Level Range:	+5.0 to -15.0 dBm.
Bandwidth (±3 dB):	DC to 25 kHz. Usable to 200 kHz.
Modulation Scaling:	+1.0 dB/volt (nominal).
Input Voltage:	±15 V maximum.
Input Impedance:	10 kΩ (nominal).

Table 1-1 Specifications - Continued

FM Modulation Input (rear panel J8):	Available only when the RF output is not phase locked.
Maximum Deviation:	±25 MHz for rates to 100 kHz; ±5 MHz for rates to 250 kHz. ±40 MHz is typically available.
Bandwidth (±3 dB):	DC to 250 kHz.
Scaling:	-6.0 MHz/volt (nominal).
Input Voltage:	±15 V maximum.
Input Impedance:	2 kΩ (nominal).
Penlift Output (rear panel J9):	Pulse is coincident with internal sweep retrace period.
Output Pulse:	CMOS/HC/TTL compatible.
Pulse Width:	9.5 millisecond (nominal).
Output LO (Sweep):	Sink 4 mA.
Output HI (Retrace):	Source 4 mA.
CHIO Input (rear panel J10):	Use of this port as an input or output invalidates RF level specifications. See Option 06.
Output Pulse:	CMOS/HC/TTL compatible.
Pulse Width:	100 µS minumum; unlimited maximum.
Input Impedance:	10 kΩ (nominal) to +5V.

GENERAL.

Designed to satisfy MIL-T-28800 for Type 3, Class 5, Color R. The typical internal temperature rise is < 5°C if 33.5 cfm of air is available for the instrument fan.

Table 1-1 Specifications - Continued

Operating Temperature:	0°C to +50°C ≤ 90% relative humidity.
Storage Temperature:	-40°C to +70°C.
Dimensions:	5.75"H x 8.38"W x 21.75"D. 146mm H x 213mm W x 553mm D.
Maximum Weight:	26 pounds (11.8 kG).
Package Type:	Standard 5.25" half-rack.

AC Power Requirements.

Line Voltage:	100, 115, 220, or 240 VAC -10% +5%.
Line Frequency Range:	< 47.5 Hz to > 63 Hz.
Grounding:	AC source may be grounded on either or neither side of line.
Power Cord:	3-wire grounding, US standard or selected international types.

Power Dissipation:

Model	Typical	Maximum
1904-B	40 W	55 W
1908-B	50 W	65 W
1910-B	60 W	70 W
1912-B	60 W	75 W
1918-B	65 W	80 W
1926-B	75 W	95 W

OPTIONS.

AC Line Voltage.

Specify 100, 115, 220, or 240 VAC. Desired line cord type must be specified for other than 115 VAC.

02 Internal ALC.

Adds internal ALC capability; eliminates the manual level adjust (MLA) mode.

Table 1-1 Specifications - Continued

03 IEEE-488-1978 interface.

Permits remote control of all instrument functions except AC ON/OFF. Implements the following subsets: SH1 (Full); AH1 (Full); T5; TE0 (None); L4; LE0 (None); SR1 (Full); RL1 (Full); PP0 (None); DC1 (Full); DT1 (Full); and C0 (None).

04 Phaselock Delete.

Removes phase-lock capability. Required on models 1918-B, 1926-B.

05 Special Calibration.

Instrument's frequency and level errors tested and minimized for operation over temperature. Options 02 and 03 are also required.

06 Internal Modulator.

Adds an internal 27.8 kHz square-wave source used to modulate the RF output; level specifications are invalidated.

CHAPTER 2

INSTALLATION

2-1. INTRODUCTION

2-1.1 This chapter outlines the procedures for initial inspection and installation of the 19XXB Microwave Sweep Generators. The subject matter includes receiving inspection, installation criteria, initial turn-on/confidence checks, and IEEE STD 488 GPIB system interconnection. Instructions concerning preparation for reshipment are also included.

2-2. RECEIVING INSPECTION

2-2.1 Prior to accepting the unit from the shipper, inspect the condition of the shipping container for any indication of freight damage. Any sign of such damage must be noted by both the shipper and receiver and reported to the insurance investigator.

2-2.2 Immediately following removal of the unit from the shipping carton, inspect for possible physical damage incurred during shipment. Check surfaces for scratches and or dents and note the condition of knobs and connectors. Should any damage be detected, notify your nearest Systron Donner representative - DO NOT USE THE INSTRUMENT UNTIL INSTRUCTED TO DO SO BY THE REPRESENTATIVE.

2-3. POWER REQUIREMENTS

2-3.1 The 19XXB requires a main supply of 100/115 or 220/240 Vac, at 50 to 60 Hz. Power consumption is approximately 40 to 75 W depending on the model. Three internal connectors accept designated selector plugs to match the 19XXB to existing line voltage conditions.

WARNING

This is a safety Class I product, and as such, is provided with a protective grounding terminal. The detachable, three-conductor power cord couples this grounding terminal to the power source uninterrutible safety earth terminal. Do not use the unit if the safety ground is broken. An adapter which provides a chassis ground should be used whenever the power cord is mated to a two-terminal outlet.

2-3.2 Line Voltage and Fuse Selection. Before attaching the power cord, be certain that the proper voltage selector plugs and fuses are installed. Internal connectors, Jx, Jx, and Jx, accept the various selector plugs, P1, P2, and Px, to match the unit to existing line voltage conditions. See figure 2-1 for P1 and P2 wiring diagrams and table 2-1 for jumper pin and part number listings. Refer to figure 2-2 and table 2-2 for plug Px information.

CHAPTER 3

OPERATION

3-1 INTRODUCTION

3-1.1 The 19XXB is a sophisticated, microprocessor-controlled instrument which produces a CW or swept-frequency microwave output over an octave or multi-octave band. The RF output may be amplitude and frequency-modulated by external signal sources.

3-1.2 The sweeper's RF output level may be controlled manually or by an external ALC function. The Internal ALC capability is available as an option.

3-1.3 The 19XXB provides the user with five independent markers, each with 1 MHz frequency resolution.

3-3.4 Both start-stop and center-delta sweep modes are provided. Frequency sweep is normally controlled by an internal ramp, though the use of an external signal is also possible. When the internal ramp is used, each sweep is followed by a 10-millisecond (nominal) retrace period during which the RF oscillator is moved to the appropriate frequency, the RF output is turned off, and any sweep trigger events are ignored.

3-1.5 A phase-lock capability, present in most models, permits the 1900-B's RF output to be locked to an internal 100 MHz source. When the phase-lock mode is used, frequency resolution is 100 MHz and the RF output can not be frequency modulated.

3-1.6 The 19XXB has numerous additional features including a voltage proportional to the instantaneous output frequency; penlift and blanking signals; a buffered 10V ramp output; and an input which permits an internal sweep to be temporarily halted.

3-2 INSTRUMENT IDENTIFICATION

3-2.1 The model number and frequency range of each individual 19XXB can be found above the RF output connector on the front panel. The model number, serial number, AC power requirement, and fuse ratings are found on an identification tag on the rear panel.

3-3 AC POWER REQUIREMENTS.

3-3.1 The 19XXB requires a 50 to 60 Hz single-phase AC line (mains) voltage of 100, 120, 220, or 240 volts RMS. A three-wire grounding power cord is provided, and either or neither side of the AC power line may be grounded at the source.

3-3.2 The AC voltage for which the individual instrument is configured is indicated on its rear panel. If your sweeper is not configured for your local AC line voltage, refer to

the drawings below to adapt the sweeper to the local AC line voltage before applying AC power.

[Insert art showing line adapter plug setups for 100, 115, 220, and 240 VAC.]

3-3.3 Each side of the power line is fused. The fuse current ratings are indicated by labels on the rear panel and depend on the AC line voltage for which the 19XXB is configured. Fuses may open due to faults in the instrument or in the fuse, to a transient on the power line, or to an attempt to operate the sweeper on an AC line voltage for which it is not configured.

3-4 INSTRUMENT TURN-ON OPERATION.

3-4.1 General turn-on operation of the 19XXB is described below.

3-4.2 Once it has been determined that the 19XXB is configured for the local AC power line voltage, the sweeper may be turned on by applying power through the power cord and

setting the power switch to the ON position. As soon as AC power is applied, the instrument will perform the self test routine as outlined below.

3-4.3 Lamp Test: After a momentarily blank display, the decimal points and the segments of each of the sweeper's thirteen numeric displays should light for about one second. The displays should then blank and each annunciator and indicator in the front panel switches should light, again for about one second.

3-4.4 Option Identification: Immediately after the end of the lamp test routine, the front panel display indicates which options, if any, are present in the instrument. Each option message is displayed for a few seconds.

3-4.5 If the 19XXB is equipped with the Phaselock option, the display will indicate "Phase Loc." Next, if the sweeper possesses the internal ALC option, the display indicates "Int ALc." Finally, if the IEEE-488 interface is present, the display indicates "IEEE" and a two-digit number showing, in decimal form, the address to which the 19XXB has been set.

3-4.6 Frequency Range and Output Power: After completion of the lamp test and option identification routines described above, the 19XXB is ready for use. The left and center displays indicate the sweeper's specified frequency range, and the right display shows the specified maximum output power. The 19XXB is now in the Start-Stop sweep mode with a sweep time of 1.000 second.

[Insert art showing lamp test and the various option displays.]

3-5 OPERATING CONTROLS AND INDICATORS

3-5.1 THE EDIT KEYS AND THE CURSOR: These are the four arrow-faced keyswitches on the front panel. Each is named by the direction its arrow points: [UP], [DOWN], [LEFT], and [RIGHT].

3-5.2 When a parameter is selected for examination or alteration the rightmost digit of the appropriate display blinks. This blinking digit, called the cursor, identifies the display which will be affected. The position of the cursor within the display indicates the step size which occurs if a parameter change should be made. [LEFT] moves the cursor to the left while [RIGHT] moves the cursor to the right (except in the Phaselock mode, where they are not operative). Frequency step sizes are 1, 10, 100, and 1000 MHz; RF level step sizes are 0.1 and 1.0 dB; and the sweep time step sizes are 0.005, 0.01, 0.1 and 1.0 seconds.

3-5.3 The leftmost digit of a display may not be edited. If the cursor is in the leftmost editable digit and [LEFT] is pressed, the cursor rolls over to the rightmost digit; and if the cursor is in the rightmost digit and [RIGHT] is pressed, the cursor rolls over to the leftmost editable digits.

3-5.4 Repeatedly pressing [UP] increments the selected parameter until the highest value within range using the selected step size is reached, while repeatedly pressing [DOWN] decrements the parameter until the lowest value within range using the selected step size is reached. If an intended change would cause the parameter to exceed its limit, the change is not allowed, and an error message is momentarily displayed.

3-5.5 The EDIT keys do not have an auto-repeat function.

3-5.6 THE SPINWHEEL: In addition to the [UP] and [DOWN] keys, the spinwheel (knob) on the front panel may be used to alter most control settings. The change in a parameter is proportional to the direction and amount of rotation applied to the spinwheel. Clockwise rotation increments the selected parameter, while counter-clockwise rotation decrements it. The step size is selected by the [LEFT] and [RIGHT] edit keys.

3-5.7 THE [ENTER] KEY: Pressing this key disables the edit keys and the spinwheel, preventing unintentional alteration of instrument settings until a function key is again pressed. In units with the IEEE-488 interface, pressing the [ENTER] key causes the 1900-B to exit the remote mode when Go-To- Local is TRUE, or to transmit sweeper status to a receiving device when Talk Only is TRUE.

3-5.8 CW FREQUENCY MODE: This operating mode produces an RF signal at a single frequency. The RF output may be AM and/or FM modulated.

3-5.9 To select, press [CW]. The CW annunciator goes on and the left display indicates the output frequency in MHz; the center display is

blank. Resolution is initially 1 MHz.

3-5.10 Changing the CW frequency has no effect on the Start, Stop, Center, or Delta frequencies.

[Insert art showing typical CW mode front panel display.]

3-5.11 PHASELOCK FREQUENCY MODE: This operating mode phase locks the RF output to an internal reference. While in the phase-lock mode, the RF output signal can be AM modulated but not FM modulated.

3-5.12 To select, press [CW], then press [PHASE LOCK]. The LOCK annunciator goes on and the left display indicates the output frequency in MHz; the center display is blank. Resolution is fixed at 100 MHz. The frequency can be altered only by the [UP] and [DOWN] edit keys; the spinwheel and the [LEFT] and [RIGHT] edit keys are inactive.

3-5.13 Selecting Phaselock sets the CW frequency to the Phaselock frequency, but has no effect on the Start, Stop, Center, or Delta frequencies.

[Insert art showing typical Phaselock mode front panel display.]

3-5.14 START-STOP FREQUENCY SWEEP MODE: This operating mode produces an RF output which sweeps upward from the Start to the Stop frequency. The time required for each sweep is determined by the sweep time setting. The RF output may be AM and/or FM modulated.

3-5.15 To select, press [START] or [STOP] as desired. The [START] and [STOP] annunciators go on and, depending on the trigger mode used, the SWEEP annunciator may flash. The left display indicates the Start frequency in MHz and the center display the Stop frequency in MHz. In both cases, resolution is initially 1 MHz.

3-5.16 Changing the Start or Stop frequency has no effect on the CW, Center, or Delta frequencies.

[Insert art showing typical Start/Stop mode front panel display.]

3-5.17 CENTER-DELTA FREQUENCY SWEEP MODE: This operating mode produces an RF output whose swept width is equal to the Delta frequency, the sweep being centered on and upward through the Center frequency. The time required for each sweep is determined by the sweep time setting. The RF output may be AM and/or FM modulated.

3-5.18 To select, press [CENTER] or [DELTA] as desired. The Center and Delta annunciators go on and, depending on the trigger mode used, the SWEEP annunciator may flash. The left display indicates the Center frequency in MHz and the center display the [DELTA] frequency in MHz. In both cases, resolution is initially 1 MHz.

3-5.19 Changing the Center or Delta frequency has no effect on the CW, Start, or Stop frequencies.

[Insert art showing typical Center/-Delta mode front panel display.]

3-5.20 SETTING THE SWEEP TIME: This parameter determines the duration of a frequency sweep. The sweep time can be set from 0.010 to more than 20 seconds, and will be extended beyond the displayed value if a Halt signal is applied.

3-5.21 To select, press [SWP TIME] while in either sweep mode. The TIME annunciator goes on and, depending on the trigger mode used, the SWEEP annunciator may flash. The left display blanks and the center display indicates the sweep time in seconds. Resolution is initially 5 milliseconds.

[Insert art showing typical Sweep Time front panel display.]

3-5.22 SETTING THE RF OUTPUT LEVEL: The instrument's average RF output level is displayed with a resolution of 0.1 dB. The adjustment range is at least -15.0 dBm to +5.0 dBm.

3-5.23 To set the RF output level, press [RF LVL].

3-5.24 For 19XXBs using internal or calibrated external ALC, the display indicates the RF output in dBm. Level setpoint resolution is initially 0.1 dB using the edit keys, or 0.05 dB using the spinwheel. With the cursor in the 1 db position, level setpoint resolution is 1.0 dB using either keys or spinwheel.

3-5.25 For units using neither internal nor external ALC, the display indicates the nominal output level. In this manual level adjust (MLA) mode, resolution and accuracy are not specified.

3-5.26 When internal or calibrated external ALC is used, the value indicated by the level display is the average output power. At the faster sweep rates the display reads less than the actual level when the RF output is muted during the retrace period.

3-5.27 THE [RF ON] KEYSWITCH: The [RF ON] keyswitch permits the sweeper's RF output to be turned on or off (muted) without altering any other instrument settings. Pressing the keyswitch overrides the RF level setting and toggles the unit from the one state to the other. When an RF output is present, the keyswitch LED is lit. When the RF output is muted, the keyswitch LED is turned off, and the RF level display reads -19.9 dBm.

3-5.28 EXTERNAL ALC: This function permits external sensing of the 19XXB's RF output so that the RF level at a point remote from the sweeper can be kept constant.

3-5.29 To select, press [EXT ALC]. When external ALC is selected the EXT ALC switch LED is lit.

3-5.30 The RF output must be connected to a directional detector with a negative detector output. The detector should be located at a point electrically close to the load, and its output must be connected to the sweeper's External ALC input.

3-5.31 As with internal ALC, the RF level display indicates the average output power.

[Insert art showing a typical use of EXT ALC function.]

3-5.32 Calibrating the External ALC Input: If the level display is correctly to indicate the power applied to the load, the external ALC input must be calibrated.

3-5.33 This requires an RF power meter and a suitable directional detector with a sensitivity of -10 to -40 microvolts per microwatt (i.e. a coupling factor of 10 to 16 dB).

(1) Connect the sweeper's RF output to the RF input of the directional detector. Connect the detector output to the sweeper's Ext ALC input. Connect the power meter to the output of the directional detector.

(2) Set the 19XXB for CW mode at the center of the span of frequencies of interest. Verify that the external RF power meter reads the correct level as modified by the setup's insertion loss.

(3) Select [EXT ALC].

(4) Set an RF level display of -15.0 dBm and adjust EXT DET OS on the sweeper's rear panel for a measured RF output of -15.00 dBm.

(5) Set an RF level display of +5.0 dBm and adjust EXT DET GAIN on the sweeper's rear panel for a measured RF output of +5.00 dBm.

(6) Repeat steps (4) and (5) until both requirements can be met without further adjustment.

[Insert art showing calibration of EXT ALC input.]

3-5.34 MARKERS: A marker occurs when the frequency of the 19XXB's output is equal to some preset point within the span of the sweep. The 19XXB is provided with five separate markers. The Marker output may be a positive- or negative-going pulse about 1 millisecond long, with any of several voltage limits as desired. For further information, see User Selectable Features below.

3-5.35 Markers within the limits of a sweep may be made active (turned on) or inactive (turned off) as desired. Markers outside the limits of the sweep are always inactive. The status of each marker is indicated by the LED in its associated keyswitch; if the marker is active the appropriate switch LED is lit.

3-5.36 To select a marker, press the desired marker switch [M1] to [M5]. The MKR annunciator goes on. The left display reads "Ent" followed by the reference number of the selected marker, and the center display indicates the present marker frequency. If the marker frequency is within the limits of the existing sweep, the marker becomes active and the LED in its keyswitch is lit.

3-5.37 To change a marker's status from active to inactive, or vice versa, select the marker by pressing [M1] to [M5] as appropriate. If the marker is active, press [CLR MKR] to turn it off. If the marker is inactive and within the limits of the sweep, press [CLR MKR] to turn it on. A marker outside the limits of the sweep can not be made active.

[Insert art showing typical marker display.]

3-5.38 Marker Limitations: Markers may not operate as expected if a marker is placed closer to the endpoints of a sweep than the limit imposed by the marker accuracy specification.

3-5.39 Markers may not operate as expected if two or more markers are placed closer together than the limit imposed by the marker accuracy specification.

3-5.40 Markers will not operate as expected if two or more markers are placed closer together in frequency than the span covered by a 2 millisecond portion of the sweep. Under such circumstances, the higher-frequency marker(s) are displaced in frequency so as to maintain this minimum time spacing. For a sweep width of 1 GHz, therefore, markers may not be placed closer together than 200 MHz if the sweep time is 10 mS, or 20 MHz if the sweep time is 100 mS.

3-5.41 Operation of the marker circuitry is not guaranteed in the external sweep mode.

[Insert art showing typical test setup using markers.]

3-5.42 SWEEP TRIGGER MODES: The 19XXB has four sweep trigger modes: auto (recurrent), manual, line, and external. When changing from the CW or Phaselock mode to either sweep mode, AUTO trigger is always initially selected. A change from Start-Stop to Center-Delta sweep mode, or vice versa, has no effect on the selected trigger mode.

3-5.43 The SWEEP annunciator is lit while a sweep is in progress. The annunciator goes off at the start of the retrace period and remains off until the next sweep trigger occurs.

3-5.44 AUTO Trigger: Selecting this mode terminates any existing sweep, then causes continuous recurrent sweeps, each one triggered automatically at the end of the retrace period. To select, press [AUTO].

3-5.45 MANUAL Trigger: Selecting this mode terminates any existing sweep, then initiates one single sweep. Each successive use of the [MAN] trigger switch, if made after the end of the retrace period, initiates a new sweep. To select, press [MAN].

3-5.46 LINE Trigger: Selecting this mode terminates any existing sweep, then initiates a new sweep upon a positive-going transition of the AC line voltage after the end of the retrace period which followed the previous sweep.

3-5.47 To select, press [LINE]. Additional pressings of the [LINE] switch while in the Line Trigger mode select the opposite slope of the triggering waveform: if the positive slope was selected the unit will then respond instead to the negative slope, and vice versa.

3-5.48 EXT Trigger: Selecting this mode terminates any existing sweep, then initiates a single sweep upon the occurrence of a positive-going transition at the front panel EXT TRIG connector. After the end of the sweep and its retrace period, a new trigger will initiate another sweep.

3-5.49 To select, press [EXT]. Additional pressings of the [EXT] trigger switch while in the External Trigger mode select the opposite

slope of the triggering waveform: if the positive slope was selected the unit will then respond instead to the negative slope, and vice versa.

3-5.50 The external trigger is intended to be used with a TTL or CMOS logic device, a transistor, etc. An internal pullup resistor to +5 volts DC is provided within the 19XXB.

[Insert art showing typical use of external trigger mode.]

3-5.51 ADDITIONAL FUNCTIONS AND ABILITIES (Rear Panel): The 19XXB is equipped with a number of additional inputs and outputs which greatly enhance its versatility and usefulness.

3-5.52 Application of any voltage to an output, or of an excessive voltage to an input, may damage the sweeper or interfere with its operation.

3-5.53 J1. V(F) Output. This port yields a voltage directly proportional to the 19XXB's instantaneous output frequency exclusive of frequency modulation. For most models the voltage is scaled at +1 volt/GHz, and for the 1926B the voltage is scaled at +0.5 volt/GHz.

3-5.54 J2. +10V Ramp Output: When the internal ramp is used, this port provides a 0 to +10 volt linear ramp synchronous with, and proportional to, the completed portion of the sweep. If external sweep has been selected, the port provides a buffered version of the applied external signal.

3-5.55 J3. Ramp Input: Selection of appropriate internal jumpers permits the use of an externally provided 0 to +10 volt ramp, or similar signal, to control the sweeper's output frequency. The internal sweep functions are disabled, but control over the output frequency may be performed as usual by setting the Start-Stop or Center-Delta frequency parameters. Marker operation is not guaranteed in external sweep, and the user is responsible for satisfying all retrace requirements.

3-5.56 J4. Marker Output: This port produces a 1-mS pulse upon coincidence of the 1900-B's output frequency and an active marker during a sweep. Selection of appropriate internal jumpers permits a choice of output voltages.

3-5.57 J5. Halt Input: An external +5V signal at this port temporarily halts an occurring sweep or prevents a sweep from occurring. Used in conjunction with a counter and appropriate external circuitry, this port may be used to determine the exact frequency at which an external device produces a specific response.

3-5.58 J6. NZ Blanking: This port produces a negative-going 9-mS pulse usable in dimming or blanking external CRT displays. The signal may also be used as a penlift command for some recorder types. Selection of appropriate internal jumpers permits a choice of output voltages.

3-5.59 J7. External AM Input: When internal ALC is used, a DC to 50 kHz signal scaled at +1 dB per volt will amplitude modulate the sweeper's RF output. External AM is available but unspecified if external ALC is used, and is not available during manual level adjustment.

3-5.60 J8. External FM Input: An externally applied signal scaled at -6 MHz per volt will frequency modulate the sweeper's RF output. External FM is available at any time that the RF output is not phase-locked.

3-5.61 J9. Penlift Output: This port produces a positive going 9-mS pulse at the end of each sweep, during the retrace period. The RF output is normally off during the penlift pulse.

3-5.62 J10. CHIO (Chop Input/-Output): For sweepers without the internal modulator option this port may be configured as an input to switch the sweeper's RF output off when a ground is applied. For sweepers with the internal modulator option this port provides a 27.8 kHz TTL- and CMOS-compatible square wave for use by external equipment; the same square wave also modulates the sweeper's RF output, and selection of an internal jumper permits either a logic HI or LO to occur during periods when the 19XXB's RF output is off.

[Insert art showing several uses of the auxiliary outputs.]

3-6. USER-SELECTABLE FEATURES.

3-6.1 Circuit reconfiguration is generally performed with the aid of small jumper connectors. Some jumpers are either installed or removed, while others have two possible positions called HI and LO. In the latter case, the jumper is in the HI position if it connects its central pin to the pin furthest away from the card-edge connector fingers on the PC board, and in the LO position if it connects its central pin to the pin nearest the card-edge connector fingers.

[Insert art showing typical jumper installed, removed, HI, and LO.]

3-6.2 Changing Instrument Configuration. To change the instrument configuration, begin by removing AC power from the instrument. Remove the top cover by unscrewing the two securing screws. Slide the cover rearward about 3/8 inch (1 cm), then lift the cover free of the 19XXB.

3-6.3 RF Muting During Retrace. Normally, the sweeper's RF output is muted (turned off) during sweep retrace. To disable this feature, remove A2CR9.

[Insert art showing A2CR9].

3-6.4 Internal and External Sweep. The 19XXB is normally configured for internal sweep when first shipped from the factory. For external sweep, remove A3W1, then install A3W2 and A3W3.

3-6.5 For internal sweep, remove A3W2 and A3W3, then install A3W1.

[Insert art showing positions of A3W1, W2, and W3 for internal sweep and for external sweep].

3-6.6 Marker Output Configurations.

3-6.7 For a TTL- and CMOS-compatible pulse, place A11SW5 HI.

(a) For a positive-going pulse, place A11SW6 HI.

(b) For a negative-going pulse, place A11SW6 LO.

3-6.8 For a negative-going non-logic pulse, place A11SW5 LO. (A11SW6 may be in either position).

(a) For a positive limit of +4.5V, place A11SW3 LO.

(b) For a positive limit of 0.0V, place A11SW3 HI.

(c) For a negative limit of -4.5V, place A11SW4 LO.

(d) For a negative limit of -13.5V, place A11SW4 HI.

[Insert art showing A11SW3, SW4, SW5, and SW6].

3-6.9 NZ Blanking Output Configurations.

3-6.10 Select the voltage limits for the blanking pulse.

(a) For a positive limit of +4.5V, place A11SW1 LO.

(b) For a positive limit of 0.0V, place A11SW1 HI.

(c) For a negative limit of -4.5V, place A11SW2 LO.

(d) For a negative limit of -13.5V, place A11SW2 HI.

[Insert art showing A11SW1 and SW2].

3-6.11 Optional Internal Modulator Configurations.

3-6.12 If the option is not installed, or if an external source is to be used, remove A11SW8 and place A11SW7 HI. A LO at J10 will now turn off the RF output.

3-6.13 If the option is installed and is to be used, install A11SW8.

(a) If the signal at J10 is to be a HI when the sweeper's RF is off, place A11SW7 HI.

(b) If the signal at J10 is to be a LO when the sweeper's RF is off, place A11SW7 LO.

(c) Use the CHOP ADJ control (A12R4) on the rear panel to set the frequency of the pulse rate, normally 27.8 kHz.

[Insert art showing A11SW7 and SW8].

3-7 IEEE-488 INTERFACE.

3-7.1 The IEEE-488 (1978) interface permits remote control of all instrument functions save for AC power on-off switching. Operation of the 19XXB via the IEEE-488 interface is described below.

3-7.2 IEEE-488 Configuration Switch A12S1.

3-7.3 This 8-position DIP switch is accessible from the rear panel. The leftmost switch (when viewing from the rear) is not used. The next two switch sections control the manner in which the sweeper interacts with IEEE-488 interface, and the five rightmost switch sections set the instrument's IEEE address. A switch is in the "1" position when its slider is moved upwards toward the top of the instrument, and in the "0" position when moved down.

[Insert art showing view of A12S1 from the rear panel.]

3-7.4 Local Lockout Switch Element.

3-7.5 In the "0" position the sweeper responds to the GTL (Go To Local) device command by returning instrument control to the front panel. The sweeper can also be returned to front-panel control by pressing the ENTER key or disconnecting the interface cable. In the "1" position the sweeper ignores the GTL command. Here, the sweeper may be returned to front-panel control only by disconnecting the interface cable.

3-7.6 The switch setting is read only during the power-on routine, and later changes are ignored.

3-7.7 Talk/Program Switch Element.

3-7.8 In the "0" position the sweeper is in the "program" mode and responds to commands and to requests for information. Here, the sweeper talks whenever so instructed by the controller, and the message it sends may be either a response to an inquiry or an internally-generated error message, depending on circumstances. Refer to paragraph 3-8.15 the Message Queue section, below, for further information.

3-7.9 In the "1" position the sweeper is in the "talk-only" mode and ignores all external commands. Here, the sweeper transmits complete information on its internal setup and status whenever the front-panel [ENTER] keyswitch is pressed. The receiving device(s) must be equipped either with a "listen-only" function or a listen-only interface converter of a type appropriate for the receiver's input system.

3-7.10 The CPU reads the status of this switch element often; thus, the setting of this switch element may be changed at any time.

3-7.11 IEEE-488 Address Switch Elements.

3-7.12 Coding for these five switch elements is in binary. The rightmost switch is the least significant element. IEEE addresses from 00 (00000) to 30 (11110) are allowed. Address 31 (11111) must not be assigned to any device interfacing the bus, since this address is reserved for the UNL (unlisten) and UNT (untalk) commands.

3-7.13 The IEEE address is read only during the power-on routine, and later changes are ignored. The 19XXB is usually shipped from the factory with the address set to 25 (11001).

3-7.14 Remote Operation Indicator.

3-7.15 When the sweeper is being controlled via the IEEE interface, the rightmost decimal point in the left display is illuminated. This decimal point is off when the sweeper is being controlled via the front panel.

[Insert art showing location of the remote indicator, with the unit in the start-stop sweep mode.]

3-8 USING THE IEEE-488 INTERFACE.

3-8.1 The 19XXB's IEEE-488 interface responds to numeric commands, to non-numeric commands, and to inquiries. These terms are defined below.

3-8.2 A numeric command is one that directly sets the numeric value of an operating parameter. Data in a

numeric command may be expressed in either scientific or engineering notation. Regardless of the method used to represent such data, excess precision is truncated.

3-8.3 A non-numeric command sets the state of the controlled function, typically on or off.

3-8.4 An inquiry is a request for information. Any term ending in a question mark is treated as an inquiry. Upon receiving an inquiry, the sweeper prepares an appropriate response which may be then read by the controller.

3-8.5 Messages To The Instrument.

3-8.6 All transmissions to the 19XXB must be terminated with a carriage return [CR] or a line feed [LF]; most controllers will perform this task automatically. Both codes may be sent but if so the second is ignored. Any combination of commands and inquiries may be sent in a single statement, so long as the message length does not exceed 256 characters. Longer messages are truncated, and problems will occur due to the absence of the [CR] or [LF].

3-8.7 Colons, semicolons, and commas are ignored. To facilitate program readability, spaces should be used to differentiate between sequential commands within a message, but spaces are otherwise ignored and are not required.

3-8.8 Messages From The Instrument.

3-8.9 Messages sent by the 19XXB are terminated with a carriage return [CR] and line feed [LF]. Such messages inform the controller of either a parameter's status (and value when applicable), or an error condition of some sort within the sweeper.

3-8.10 Excluding the [CR][LF], the sweeper's response may be anywhere from 1 to 24 characters in length, depending on the specific message. The shortest response is the no-data message, which consists of a space [SP], carriage return [CR], and line feed [LF].

3-8.11 Numeric data sent by the sweeper is formatted in engineering notation (i.e. the exponent is 10^0, 10^3, 10^6, and so on) and is placed in the final 11 characters before the [CR][LF]. All error messages begin with a question mark, which may be used as a flag by the controller. The 19XXB generates three different error messages.

3-8.12 An "? ILLEGAL PROGRAM SYNTAX" message may occur when the sweeper encounters an unrecognized, mispelled, or incorrect command, as well as when it receives any term incorrectly used as an inquiry.

3-8.13 An "? (parameter's name) OUT OF RANGE" message may occur when a numeric value exceeds the limits of the parameter to be controlled. Under such circumstances, the parameter does not change from its prior value.

3-8.14 A "? PHLOCK NOT INSTALLED" message may occur if the sweeper does not have the Phaselock option and a phaselock command or inquiry is sent.

3-8.15 The Message Queue. The sweeper has a message queue which may be disabled or enabled as desired. This

queue is normally disabled when the instrument is first turned on and must be enabled before it can be used.

3-8.16 If the message queue is disabled the sweeper sends only the most recent message; this will be the appropriate response to the most recent inquiry, or the appropriate error message, if any, when the bus is read without an inquiry.

3-8.17 Assume that the sweeper is in the CW mode at a frequency of 9.000 GHz. A sample response to a partial BASIC-like program when the message queue is disabled is given below.

```
1010 PRINT #1, "HRMPH STR 99E9
     CW?  RF?"
1020 INPUT #1, MESSAGE$
1030 PRINT MESSAGE$
1040 IF MESSAGE$ = "[SP]" THEN
     END
1050 GOTO 1020
```

Responding to line 1040, the controller prints:

```
RF ON [CR][LF]
[SP] [CR] [LF]
```

and then halts, since only one message is sent.

3-8.18 When the message queue is enabled, the sweeper's responses are sent in a first-in, first-out manner, with error messages and inquiry responses having equal priority. If the sweeper is not allowed to send everything in the queue, its messages may be displaced from their stimuli. Using the same initial conditions and partial program presented above, the controller prints:

```
? ILLEGAL PROGRAM SYNTAX
[CR][LF]
? START OUT OF RANGE [CR][LF]
 CW ON +9.000E+09 [CR][LF]
RF ON [CR][LF]
[SP] [CR] [LF]
```

and then halts.

3-9 KEYWORDS, ALTERNATIVES, AND OPERATIVES.

3-9.1 The 19XXB recognizes two different keywords for most commands. The primary set uses short mnemonic letter combinations which may appear somewhat obscure but which consume relatively little space in a user's program. The alternative or secondary set is English-language-like and thus generally self-explanatory, but requires significantly longer keywords. Keywords from each set may be mixed and interchanged as the user desires.

3-9.2 The table 3-1 below contains an alphabetical list of valid keywords, their alternatives, and the allowable operators for each. Following table 3-1 are tables (table 3-2 thru 3-7) containing a detailed description of the use of each keyword with its permissible operators. Where required, numeric data is indicated by {#E#} regardless of the selected format. Responses from the sweeper always use the alternative keyword, and numeric data is presented in engineering notation.

Table 3-1 Keyword and Alternates

Keyword	Alternate	Valid Operators
AUT	AUTO	(none)
CEN	CENTER	?, {#E#}
CW	CWM	?, {#E#}
DLT	DELTA	?, {#E#}
GTL	GTL	(none)
LIN	LINE	(none)
LVL	LEVEL	?, {#E#}
MAN	MANUAL	(none)
MKRn	MARKERn	?, {#E#}, OFF, ON
PHL	PHLOCK	?, {#E#}, OFF, ON
QU	QU	0, 1
RF	RF	?, OFF, ON
SR	SR	0, 1
STO	STOP	?, {#E#}
STR	START	?, {#E#}
TIM	TIME	?, {#E#}
TRG	TRIG	?
XLC	EXTALC	OFF, ON
XTR	EXTTRG	POS, NEG

Table 3-2
Frequency and Mode Commands.

COMMAND	FUNCTION
CEN {#E#}	Selects the Center-Delta mode and sets the Center frequency to {#E#} Hz.
CEN?	Returns "CENTER OFF {#E#}" if the Center-Delta mode is not active, or "CENTER ON {#E#}" if the Center-Delta mode is active.

Table 3-2
Frequency and Mode Commands cont.

CW {#E#}	Selects the CW mode and sets the CW frequency to {#E#} Hz.
CW?	Returns "CW OFF {#E#}" if the CW mode is not active, or "CW ON {#E#}" if the CW mode is active.
DLT {#E#}	Selects the Center-Delta mode and sets the Delta frequency to {#E#} Hz.
DLT?	Returns "DELTA OFF {#E#}" if the Center-Delta mode is not active, or "DELTA ON {#E#}" if the Center-Delta mode is active.
PHL {#E#}	Selects the Phase-lock mode and sets the Phaselock and CW frequencies to {#E#} Hz.
PHL OFF	Turns the Phaselock mode off and sets the sweeper to the CW mode. The CW frequency is the same as the former Phase-lock frequency.
PHL ON	Selects the Phase-lock mode and sets the Phaselock frequency to the nearest

Table 3-2
Frequency and Mode Commands cont.

PHL ON cont.	100 MHz. If the sweeper was in the CW mode prior to being placed in the Phaselock mode, the CW frequency becomes equal to the new Phaselock frequency.
PHL?	Returns "PHLOCK OFF {#E#}" if Phaselock is not selected, "PHLOCK ON {#E#}" if the Phaselock mode is active, or "? PHLOCK NOT INSTALLED" if the Phaselock option is not present.
STO {#E#}	Selects the Start-Stop mode and sets the Stop frequency to {#E#} Hz.
STO?	Returns "STOP OFF {#E#}" if the Start-Stop mode is not active, or "STOP ON {#E#}" if the Start-Stop mode is active.
STR {#E#}	Selects the Start-Stop mode and sets the Start frequency to {#E#} Hz.
STR?	Returns "START OFF {#E#}" if the Start-Stop mode is not active, or "START ON {#E#}" if the Start-Stop mode is active.
MKRn {#E#}	Sets the frequency of marker number "n" to {#E#} Hz.

Table 3-3 Marker Commands

MKRn ON	Sets marker number "n" active, if the marker's frequency remains within the limits of the existing sweep.
MKRn OFF	Sets marker number "n" inactive. If the sweep frequency is later changed so as to include the freqency of this marker, the marker automatically becomes active again.
MKRn?	Returns "MARKERn ON {#E#}" if the marker number "n" is active, or "MARKERn OFF {#E#}" if the marker is inactive.

Table 3-4
Sweep Trigger Commands.

AUT	Selects the auto (recurrent) trigger mode.
LIN POS	Selects the AC line trigger mode with positive slope.
LIN NEG	Selects the AC line trigger mode with
MAN	Selects the manual trigger mode and initiates a sweep. Further MAN commands after the end of a sweep and its retrace period initiate

Table 3-4
Sweep Trigger Commands cont.

MAN cont.	additional sweeps; MAN commands received during a sweep are ignored.
TRG?	Returns "TRIG AUTO" if auto trigger is selected, "TRIG LIN POS" or "TRIG LIN NEG" if positive or negative line trigger is selected, and "TRIG XTR POS" or "TRIG XTR NEG" if positive or negative external trigger is selected.
XTR POS	Selects the external trigger mode with positive slope.
XTR NEG	Selects the external trigger mode with negative slope.

Table 3-5 Sweep Time Commands

TIM {#E#}	Sets the sweep time to {#E#} seconds. Sweep time may be set only in 5 millisecond increments.
TIM?	Returns "TIME {#E#}" to indicate the existing sweep time setting in seconds.

Table 3-6
RF Level and Control Commands.

LVL {#E#}	Sets the RF level setpoint to {#E#} dBm if an ALC mode is selected, or to the equivalent arbitrary value if the manual level adjustment mode is selected. Values from +19.9 to -19.9 dBm are accepted even if such values are in excess of the available RF power.
LVL?	Returns"LEVEL {#E#}" for the existing RF output level in dBm.
RF OFF	Switches the sweeper's RF output off if it is on, and has no effect if the RF output is off.
RF ON	Switches the sweeper's RF output on if it is off, and has no effect if the RF output is on.
RF?	Returns "RF ON" if the sweeper's RF output is on and "RF OFF" if the RF output is muted.
XLC ON	Places the sweeper in the external ALC mode.

Table 3-6
RF Level and Control Commands cont.

XLC OFF	Places the sweeper in the internal ALC mode if the instrument has the internal ALC option, or the manual level adjust mode otherwise.
XLC?	Returns "EXTALC ON" if external ALC is selected or "EXTALC OFF" otherwise.

Table 3-7 Additional Commands

GTL	Returns the 1900B to local (front-panel) mode. GTL is ignored if Local Lockout is true.
QU0	Disables the message queue function. This is the normal power-on state.
QU1	Enables a special first-in, first-out message que function which permits the 1900B to transmit all appropriate messages. All messages are considered equal in priority whether generated by an error condition or by an inquiry.
SR0	Disables the service request function.

Table 3-7 Additional Commands cont.

SR0 cont	This will disable the sweeper's ability to request service, clears any current service request condition, and clears the serial poll status byte. This is the normal or default state.
SR1	Enables the service request function. The sweeper will request service by asserting the SRQ line when it detects an error condition.

3-10 PROGRAMMING EXAMPLES.

3-10.1 This section provides several sample program command sequences. The examples assume a sweeper with a frequency range of from 2.00 to 10.00 GHz.

PROGRAMMING EXAMPLE 1.

To generate a CW signal at 8.345 GHz, send the following:

```
  CW 8.345E+09 [CR]
or
  CW 8345E06 [CR]
or
  CW .8345000E+10 [CR]
or even
  CW 8345000000 [CR].
```

PROGRAMMING EXAMPLE 2.

The sweeper is in the Start-Stop

sweep mode. The most recently set CW frequency is 10.000 GHz. If
  CW? [CR]
is sent the sweeper goes into remote operation and responds with
  CW OFF +10.000E+09 [CR][LF]
when the bus is read. The sweeper remains in the Start/Stop mode with unchanged frequencies.

PROGRAMMING EXAMPLE 3.

The sweeper is in CW mode at 6.234 GHz. If the faulty command
  CW 1.234E06 [CR]
is sent, the sweeper goes to remote operation but remains in the Start/Stop mode with unchanged frequencies due to the illegal CW frequency.

If the message queue is disabled, sending
  CW? [CR]
produces the response
  CW ON +6.234E+09 [CR][LF]
when the bus is read.

If the message queue is enabled, sending
  CW 1.234E06 [CR]
produces the response
  CW OUT OF RANGE [CR][LF]
when the bus is read. Note that no inquiry was required to detect the error condition.

PROGRAMMING EXAMPLE 4.

The sweeper has a Start frequency of 9.211 GHz, a Stop frequency of 9.611 GHz, and a sweep time of 1.000 seconds. Wanting to change the Start frequency to 2.500 GHz and the sweep time of 3.625 seconds, we send:
    STA 2.5E+09 TIM 3625E-03 [CR]
and discover that the sweeper does not accept the new start frequency. This is due to the use of the invalid keyword STA. The IEEE interface standard uses STA as a mnemonic for a specific and distinct function; the keyword for the Start frequency is STR.

To continue with the example, we ignore the fault for the moment and send
  TIM? [CR].

If the message queue is disabled, the response
  TIME 3.625E+00 [CR][LF]
occurs when the bus is read. However, if the message queue is enabled, reading the bus results in
  ? ILLEGAL PROGRAM SYNTAX [CR][LF]
which might appear to indicate an instrument fault of some sort. Only when we read the bus a second time do we receive the information requested by the inquiry,
  TIME 3.625E+00 [CR][LF].

PROGRAMMING EXAMPLE 5.

The instrument is under front-panel control with a Start frequency of 9.211 GHz and a Stop frequency of 9.611 GHz. If we send
  STR 2.5E09 STO 5.5E06 [CR]
the out-of-range Stop frequency of 5.5 MHz is not accepted.

If the message queue is active and we send
  STR? STO? [CR]
three successive readings the bus provide us with
  ? STOP OUT OF RANGE [CR][LF]
  START ON +2.500E+09 [CR][LF]
and
  STOP ON +9.611E+09 [CR][LF]
which indicate the error and correctly describes the sweeper's settings.

PROGRAMMING EXAMPLE 6.

The instrument has a Start frequency of 9.211 GHz and a Stop frequency of 9.611 GHz. A previously set CW frequency was 2.000 GHz. If we send

PHL? [CR],

the sweeper responds with

PHLOCK OFF +2.000E09.

If we then send

PHL ON PHL? [CR]

and read the bus, we receive the message

CW OFF [CR][LF].

Only if we first place the sweeper in the CW mode can we then select the Phaselock mode. This can be done by sending

CW PHL ON PHL [CR]

and the sweeper then goes to Phaselock mode at 2.000 GHz.

PROGRAMMING EXAMPLE 7.

The instrument is under front-panel control with a Start frequency of 9.211 GHz and a Stop frequency of 9.611 GHz. If we send

MKR1 02200E06 [CR]
MKR3 09500E06 [CR]
MKR5 02100000E3 [CR]
MKR4 06722E06 [CR]
MKR2 10E09 [CR]

we will have markers at 2.100 GHz (#5), 2.200 GHz (#1), 6.722 GHz (#4), 9.500 GHz (#3), and 10.000 GHz (#2). As marker 3 is within the range of the sweep, it becomes active; but the other markers, none of which is within the sweep range, are all inactive. If we next send

MKR3 OFF MKR3? [CR]

then marker number 3 is turned off and the sweeper responds with

MARKER3 OFF +9.500E09 [CR][LF]

when the bus is read.

PROGRAMMING EXAMPLE 8.

The instrument has a Start frequency of 9.211 GHz and a Stop frequency of 9.611 GHz. As in the previous example, markers are placed at 2.100 GHz, 2.200 GHz, 6.722 GHz, 9.500 GHz, and 10.000 GHz. If we send

MKR1 ON MKR1? [CR]

the sweeper responds with

MARKER1 OFF +2.200E09 [CR][LF]

when the bus is read. If we now change the Start frequency by sending

STR 02000E06 MKR1? [CR]

the sweeper responds with

MARKER1 ON +2.200E09 [CR][LF]

when the bus is read.

PROGRAMMING EXAMPLE 9.

The RF output level is +5.0 dBm. If we send

LVL +015 [CR]

the instrument is set to produce an RF output level of +15 dBm, which will probably exceed the available power. Assuming that the maximum available power is +10.7 dBm, sending

LVL? [CR]

results in the message

LVL +1.07E+01 [CR][LF]

when the bus is read.

3-11 ADVANCED INTERFACE FUNCTIONS.

3-11.1 The following information may prove useful to those who wish to utilize the IEEE-488 interface to its fullest extent.

3-11.2 Implemented Interface Function Subsets. The 1900B incorporates the interface function subsets listed below. For a more complete description of these subsets refer to IEEE Std. 488-1978.

Subset Type Description

SH1	Full Source Handshake.
AH1	Full Acceptor Handshake.
T5	---- Talk, Basic Talker, Unaddressed if MLA, Serial Poll, Talk Only Mode.
TE0	None Extended Talker.
L4	---- Listen, Basic Listener, Unaddressed if MTA.
LE0	None Extended Listener.
SR1	Full Service Request.
RL1	Full Remote Local.
PP0	None Parallel Poll.
DC1	Full Device Clear.
DT1	Full Device Trigger.
C0	None Controller.

3-11.3 Polling and Status Byte Generation.

3-11.4 When an instrument in a test system generates an SRQ command (service request), the controller may attempt to identify the requesting device by serial poll. During serial poll, each device on the interface bus sends its status bite on command, and the controller checks the request bit (bit 7) to determine which device requested service. The table below indicates the status byte format used by the 1900B sweeper.

3-11.5 Service Request (SR1/SR0) The service request function is disabled when the sweeper is first turned on. When desired, the function must first be enabled by sending the SR1 command. An active service request may be disabled by sending SR0.

3-11.6 Device Clear (DCL). This command clears the sweeper's input and output buffers, disables the SRQ capability, and clears the serial poll status byte.

3-11.7 Group Enable Trigger (GET). This command initiates a single sweep if the instrument is in the internal sweep mode and manual trigger has been selected. The GET is ignored if the instrument is not in the Start-Stop or Center-Delta sweep mode, or if external sweep has been selected.

Table 3-7 Status Bit Format

Bit	Status
8	MSB. Not used.
7	Requesting service: service request enabled, bit 3 set.
6	Abnormal operation: bit is set if bit 3 is set.
5	Not used.
4	Not used.
3	Error: invalid device command.
2	Not used.
1	LSB. Not used.

CHAPTER 4

THEORY OF OPERATION
1900B MICROWAVE SWEEPERS

4 GENERAL DESCRIPTION

4-1.1 Major Circuit Cards. The 1900B contains the twelve printed circuit boards (PCBs) and assemblies described below.

4-1.1.1 A1 CPU PCB. Under command of the front panel or the IEEE-488 interface, this assembly controls all instrument functions except for AC power on/off.

4-1.1.2 A2 ALC PCB. This assembly contains the circuitry which controls the RF output level.

4-1.1.3 A3 Ramp and Marker PCB. This assembly generates the linear ramp which sweeps the output frequency, and generates the frequency markers.

4-1.1.4 A4 Frequency Control PCB. This assembly works with the A9 Heatsink Assembly to control the current through the YIG oscillator's Main Tune coil and thus the sweeper output frequency.

4-1.1.5 A5 Front Panel Driver PCB. This assembly works with the A1 CPU and the A6 Switch And Display, to display and to permit manual control of the sweeper's operating parameters.

4-1.1.6 A6 Switch And Display PCB. This assembly works with the A1 CPU and the A5 Front Panel Driver, to display and to permit manual control of, the sweeper's operating parameters.

4-1.1.7 A7 Phaselock PCB. This assembly holds microwave and other circuit elements which phase-lock the instrument's RF output to an internal 100 MHz crystal reference.

4-1.1.8 A8 Power Supply Assembly. This assembly contains the diode rectifiers, filter capacitors, and most of the voltage regulators required for instrument operation.

4-1.1.9 A9 Heatsink Assembly. This assembly mounts the microwave components and the A9 Heatsink PCB. In conjunction with the A4 and A7 PCBs, the A9 PCB controls the current thru the YIG oscillator's Main Tune and FM Tune coils to control the output frequency. The A9 Heatsink Assembly also produces several additional regulated voltages required by the YIG oscillator.

4-1.1.10 A10 Motherboard PCB. This assembly provides the majority of the circuit interconnections needed for instrument function.

4-1.1.11 A11 Vb and Interface PCB.

This assembly provides several special functions useful in, or required for, operation of the sweeper.

4-1.1.12 A12 Rear Panel PCB. This assembly mounts the controls which calibrate an external detector input, and the address-setting switch for the IEEE-488 interface.

4-1.2 THE MICROWAVE SYSTEM.

4-1.2.0 The microwave system of the 1900B consists of three main elements: an RF source, a leveling module, and a directional detector. In some instruments, a harmonic filter may also be present.

4-1.2.1 RF Source. The RF output signal is created by YIG oscillator Y1. Isolator (or pad, in some instruments) U3 is mounted to the oscillator's output connector to prevent load changes from having a major effect on the output frequency.

4-1.2.1.1 YIG Materials. YIG is an acronym used to describe various ferrite materials which behave as extremely-high-Q tuned circuits. A YIG-tuned oscillator (also called a YIG oscillator) is an otherwise conventional microwave oscillator which uses a sphere of YIG material as the frequency-determining element. Within fairly broad limits, the resonant frequency of a YIG sphere is a linear function of the strength of the magnetic field in which the sphere is located.

4-1.2.1.2 Oscillator Active Elements. Two types of YIG oscillator are commonly available. One type uses a bipolar or FET transistor as the oscillating element, while the other uses a Gunn diode. Transistor oscillators need fixed DC voltages for operation, while Gunn diode oscillators need a voltage inversely proportional to the output frequency.

4-1.2.1.3 Main Tune Coil. In a YIG oscillator, a YIG sphere is placed between the pole pieces of an electromagnet. The sphere's resonant frequency can then be adjusted by varying the field strength of the electro-magnet. Since the magnetic field strength is controlled by the current through the coil, setting that current determines the oscillator's output frequency.

4-1.2.1.3.1 The electromagnet which sets the frequency is known as the Main Tune coil. For most such coils the current-to-frequency relationship, called the tuning sensitivity, is about 20 MHz/mA, though values from 15 to 30 MHz/mA are not uncommon. Main Tune coils typically have inductances of 60 to 150 millihenries and usable bandwidths of 1 to 10 kHz. The linearity of a Main Tune coil is rarely worse than 0.2% and is typically less than 0.1%.

4-1.2.1.4 FM Coil. Most YIG oscillators are also furnished with an additional tuning coil called the FM coil, which is most often used to fine-tune or frequency-modulate the oscillator's RF output. FM coils have typical tuning sensitivities of 300 to 500 kHz/mA, inductances of about one microhenry, and usable bandwidths which may be as high as 1 MHz. The linearity of an FM coil is typically 1%.

4-1.2.1.5 Effects of Temperature. Any change in the oscillator's tem-

perature must inevitably affect the physical spacing of the electromagnet's pole pieces, resulting in a small change in the magnetic field. Temperature changes will also affect the resonant frequency of a YIG sphere; as a result, most oscillators use an internal heater to keep the sphere at a constant temperature. The output frequency of a well-designed YIG oscillator equipped with a heater should not change by more than 0.01% per degree C.

4-1.2.1.6 Hysteresis. Magnetic devices are subject to hysteresis effects. In a YIG oscillator, hysteresis results in the oscillator tuning to one frequency when the tuning current is increased to any particular point, and to a different frequency when the tuning current is decreased to that same point. Hysteresis is usually worst in the middle of the oscillator's frequency range. In most cases, hysteresis errors are rarely more than 0.05% of the output frequency.

4-1.2.1.7 Post-Tuning Drift. This is a slow to very slow change in output frequency which occurs after the oscillator is tuned to a new frequency. The primary causes of such drifts are a change in the oscillator's internal temperature as a result of the change in the power dissipated by the Main Tune coil, and a dissipation-related change in the resistance of the sense resistor used to monitor the current through the Main Tune coil.

4-1.2.1.8 Other Error Sources. Variations in an oscillator's power supply or in the load presented to its RF output also affect the output frequency. Since YIG oscillators are tuned by a magnetic field, variations in the magnetic field in which the YIG is placed will also change the frequency.

4-1.2.1.9 Why Use YIG Oscillators? The drawbacks above are either present or have close parallels in other types of microwave oscillator. The YIG oscillator remains the optimum choice for most applications due to its linear electronic tuning, the availability of octave and multi-octave coverage in a single device, a stable output frequency, low phase noise, moderate power consumption, and reasonable size.

4-1.2.2 Leveling Module U1. Y1's RF output is applied to the input of module U1, which contains a directional coupler and a PIN diode attenuator. U1's main RF output is applied either directly to the output connector, or, when the internal ALC option is present, through directional detector U2. If the Phaselock option is present, the signal from U2's coupled port is applied to a sampling mixer on the A7 Phaselock PCB to permit the RF output to be phase-locked to a 100 MHz reference. When the Phaselock option is not present, U1's coupled port is not used and is terminated.

4-1.2.2.1 PIN Diode Levelers. PIN diodes are semiconductor diodes with an insulating layer built into the semiconductor structure. When reverse-biased, a PIN diode exhibits a very low capacitance and very high resistance. As with other diode types, the effective resistance of a forward-biased PIN diode is inversely proportional to the current through it: the higher the current, the lower the resistance. These properties help to make PIN diodes useful as electrically-variable

attenuators.

4-1.2.2.1.1 One leveler type consists of a PIN diode placed across a transmission line whose impedance is matched to its RF source and a load. When the PIN diode is reverse biased it does not significantly alter the impedance of the transmission line; as a result, most of the power at the line's input appears at its output. However, if current flows through the PIN diode its resistance becomes lower, the line is no longer well-matched to the RF source, some of the RF power at the line's input is reflected back to the source, and the power at the line's output is less. The current through the diode therefore controls the insertion loss of the transmission line. Practical levelers of this type often use two or three PIN diodes.

4-1.2.3 Directional Detector U2. When the Internal ALC option is present, U2 provides the level control system with a DC voltage proportional to the instrument's RF output level.

4-1.2.3.1 Directional Couplers. A directional coupler has an input, an output, and a coupled port. The input and output ports are not interchangeable, and the device behaves quite differently depending on the direction of RF power flow. In addition to their frequency range and insertion loss, directional couplers are usually described by their coupling and isolation factors.

4-1.2.3.1.1 In the "forward" direction RF power is applied to the input and flows to a load at the output; here, a portion of the power at the input appears at the coupled port. The ratio between the power at the input and coupled ports is the coupling factor; values from 10 to 20 dB are usual.

4-1.2.3.1.2 In the "reverse" direction RF power is applied to the output and flows into a load at the input; under such circumstances the portion of the power appearing at the coupled port is much less than when the device is used in the forward direction. The difference between the forward and reverse coupling factors is the isolation factor; values from 14 to 20 dB are usual.

4-1.2.3.2 Directional Detectors. A directional detector is a directional coupler with an impedance-matched detector diode mounted to the coupled port. Over a reasonable range of RF input levels, the output of the detector is a DC voltage directly proportional to the applied RF power in milliwatts.

4-1.2.3.2.1 Directional detectors with tight coupling factors have a good response to low power levels but have poor linearity at higher power levels, where the diode begins to respond linearly instead of exponentially to the RF input. Conversely, directional detectors with loose coupling factors provide a linear response for higher input levels but have relatively poor sensitivity to lower power levels.

4-1.2.3.3 Specific Components. 1900B sweepers use a directional detector with a 16 dB coupling factor, which provides the best compromise over the specified power range. The specific device type used is chosen as appropriate for the frequency range of the individual instrument.

4-1.2.3.3.1 At low and moderate input power levels the detector's output is about 10 microvolts per microwatt of input power, or, roughly, 1 millivolt for a 1 milliwatt (0 dBm) output. The crossover from the square-law region to the linear region becomes significant at RF output levels of about +7 dBm, where the power applied to the detector diode is about -9 dBm.

4-2. A1 CPU PCB Assembly, 083413.

4-2.0 The CPU PCB Assembly contains a microprocessor, its support circuits, memory (RAM and ROM), and an optional IEEE-488 interface. Data transfer to the A2, A3, and A4 PCBs in the card cage is provided through motherboard A10, while connector J1 transfers data to the A5 Front Panel Driver PCB.

4-2.1 Power-On Reset. Timer A1U1 provides a power-on reset signal to initialize the microprocessor system when AC power is first applied to the 1900B. A1U2A inverts the timer's output to provide the required signal polarity. A1S1 forces a system reset without the need to cycle the AC power off and back on.

4-2.2 Microprocessor. A1U3 controls the operation of the 1900B sweeper in accordance with the instructions and data stored in read-only-memories (ROMs) A1U8 and A1U9. A1U3's primary control inputs and outputs are discussed briefly below.

4-2.2.1 Master Clock (E-clock). The E-clock controls all timing and data transfer within the CPU system. The 1 MHz frequency of the E-clock is set by the 4 MHz crystal A1Y1 and a divider circuit within A1U3.

4-2.2.2 Address Bus. The microprocessor has a 16-bit unidirectional address bus capable of selecting any one of 64K bytes of memory. The address lines are designated A15 (most significant) to A0.

4-2.2.3 Data Bus. The microprocessor also has an 8-bit bi-directional data bus. All data transfer to or from the CPU is carried out along these lines. The data lines are called D7 (most significant) to D0.

4-2.2.4 Read/not-Write (R/~W). The logic state of this signal determines whether the CPU reads data from, or writes data to, the address selected by the address bus. Data transfer is via the data bus.

4-2.2.5 Valid Memory Address (VMA). This signal controls the CPU system's response to the address lines. The VMA signal is true only when the information on the address bus is both correct and stable.

4-2.2.6 NotInterrupt Request (~IRQ). This input permits the CPU to respond to asynchronous external events called interrupts. The software may intentionally prevent A1U3 from responding to signals on this line; otherwise, when the ~IRQ line goes LO, the CPU halts its activity of the moment to perform software-specified actions appropriate to the nature of the interrupt.

4-2.2.7 Non-Maskable Interrupt (~NMI). This is similar to the ~IRQ input but its activation is usually reserved for the highest-priority events. System software is unable to directly prevent the CPU from responding to signals on this line.

4-2.3 Address Decoding and Alloca-

tion. A1U4 controls address selection in 8K increments. Complete decoding is not implemented and many address locations are mirrored by unused ones. Address assignments are listed below.

4-2.3.1 Addresses $0000 to $1FFF. Assigned to system RAM A1U7. Only the lowest 2K is used. A1U2B, A1U2C, and A1U2D provide control signals for the RAM and for circuits elsewhere in the instrument.

4-2.3.2 Addresses $2000 to $3FF. Assigned to the various peripheral devices that direct and control instrument operation. A1U5 provides additional decoding in 16-byte increments. Most of the address space here is unused.

4-2.3.3 Addresses $4000 to $5FFF. Assigned to the optional IEEE-488 interface, whose functions are implemented by A1U11, A1U12, and A1U13. Most of the address space here is unused.

4-2.3.4 Addresses $6000 to $7FFF. Assigned to configuration switch A1S2 and IEEE-488 address switch A12S1. A1U14 provides address decoding for the switches, while A1U10 and A1U15 isolate the switches from the data bus except when the appropriate address has been selected. Most of the address space here is unused.

4-2.3.5 Addresses $8000 to $FFFF. Assigned to ROMs A1U8 and A1U9. As address decoding by A1U4 is done in 8K increments, A1U6 combines A1U4's outputs into the 16K increments required by the two ROMs.

4-2.4 The IEEE-488 Interface. This interface receives data and instructions from an external controller and, when so requested, provides the controller with information on the sweeper's operational status. A1U11 provides the timing and handshake functions necessary for proper implementation of the interface, while A1-U12 and A1U13 translate the logic levels of the CPU to the logic levels required by the interface specification. A1J3 permits connection of A1U12 and A1U13 to the interface connector on the rear panel. A12S1 sets the instrument's IEEE address and certain other interface characteristics.

4-2.5 Configuration Switch A1S2. The data set by this switch informs the CPU of the individual 1900B's frequency range and option configuration. Table 4-1 shows the function of each switch element, while Table 4-2 identifies the frequency ranges specified by the settings of switch sections E (most significant) to A. Each switch section is in the TRUE or "1" state when its rocker is moved toward the right-hand edge of the A1 PCB.

Table 4-1
A1S2 Switch Element Functions.

Element	Function
H	Not used.
G	PHASELOCK option.
F	INTERNAL ALC option.
E	Frequency Band 2^4 bit
D	Frequency Band 2^3 bit
C	Frequency Band 2^2 bit
B	Frequency Band 2^1 bit
A	Frequency Band 2^0 bit

Table 4-1 Cont.

CAUTION

If A1S2 is set incorrectly, the

YIG oscillator may be damaged or destroyed.

Table 4-2
Frequency Band Settings.

E-to-A Hex Code	Frequency Bands
00	Calibration mode
01	10 MHz - 2000 MHz
02	1000 MHz - 4000 MHz
03	2000 MHz - 4000 MHz
04	2000 MHz - 6000 MHz
05	2000 MHz - 8000 MHz
06	2000 MHz -10000 MHz
07	4000 MHz - 8000 MHz
08	6000 MHz -18600 MHz
09	8000 MHz -12400 MHz
0A	8000 MHz -18600 MHz
0B	10000 MHz -20000 MHz
0C	12000 MHz -18600 MHz
0D	18000 MHz -26500 MHz
10	8000 MHz -12000 MHz
11	12000 MHz -18600 MHz
12	18000 MHz -26000 MHz
1F	Software Test Mode

NOTE: Refer to the calibration procedures elsewhere in the manual for further information on the calibration and software test modes.

4-3 A2 ALC PCB Assembly, 083417.

4-3.0 The A2 ALC PCB controls the RF output level, and informs the CPU of the actual RF level when either internal or external automatic level control (ALC) is selected. The A2 PCB also contains the V(f) buffer circuit.

4-3.1 Level Control Modes. The 1900B has three operating modes: internal ALC, external ALC, and manual level adjust. The manual level adjust mode is available only in units without the internal ALC option.

4-3.1.1 Internal ALC. In this mode, an optional internally mounted directional detector provides the A2 PCB with a voltage proportional to the RF output level. Level control is via a closed loop system and temperature compensation is provided.

4-3.1.2 External ALC. In this mode, a user-provided detector provides the A2 PCB with a voltage proportional to the RF output level. Level control is via a closed loop system and temperature compensation is provided.

4-3.1.3 Manual Level Adjust. In this mode, level control is via an open-loop system and temperature compensation is not provided.

4-3.2 Interface WITH CPU. A2U1 and A2U2 are Peripheral Interface Adapters (PIA's) which receive and store data from the CPU and permit the CPU to read data generated by the A2 PCB. Each PIA has two eight-bit ports whose individual bits can be configured to function either as inputs from the CPU or as latched outputs to the circuit board.

4-3.2.1 Also present in each PIA are two one-bit ports (CA2 and CB1) useful as interrupt-generating inputs, and two one-bit ports (CB1 and CB2) usable either as interrupt--generating inputs or as outputs.

4-3.2.2 Peripheral Interface Adapter A2U1. The PIA's two main ports are used as outputs which hold data to control the RF output level as well as several additional func-

tions. Three of these outputs are brought off the A2 PCB for use elsewhere in the instrument.

4-3.2.3 Peripheral Interface Adapter A2U2. One of A2U2's main ports is used as an input for data from A-to-D converter A2U16 while the second is unused. CB1 is an input which generates an interrupt each time A2U16 completes a data conversion, while CB2 is an output which causes U16 to update the data it provides to the PIA. For instruments without the internal ALC option, A2U2's interrupt ports are inactive unless external ALC is selected.

4-3.3 Detector Signal Processing. The signal applied to the external ALC input is a negative voltage proportional to the RF power in milliwatts at some location of interest to the instrument's user, and typically is derived from a detector diode attached to the coupled port of a directional coupler. The signal is applied to gain adjustment potentiometer A12R2. The voltage at the potentiometer's wiper is then connected through A2J3 to the input of differential amplifier A2U7. A12R2's adjustment range permits accomodation of coupling factors from <10 to >16 dB.

4-3.3.1 Internal ALC. When the internal ALC option is present, directional detector U2 is installed in the RF path. U2 produces a negative voltage proportional to the RF output in milliwatts. This voltage is applied to A2U8. A2R17 is factory-selected to compensate for the output of the individual directional detector.

4-3.3.2 Signal Switching. The INT/$\overline{\text{EXT}}$ ALC signal from A2U1 determines whether the output of A2U7 or A2U8 is applied to A2U10. A2U9 also selects an offset voltage from either A2R20 or the external detector offset adjustment A12R1. When properly calibrated, the signal at A2TP2 is scaled at about -0.2 V per milliwatt.

4-3.3.3 Logarithmic Amplifier A2U10. The output of logarithmic amplifier (log amp) A2U10 changes by 2V for a 10:1 change in the input voltage, regardless of the actual voltage level. As A2U10's input is proportional to an RF level expressed in milliwatts, its output is proportional to this same power level expressed in dBm. A2U10's output, the V(dBm) voltage, is scaled to +0.7893V +0.200 V/dBm. The V(dBm) voltage is applied to error amplifier A2U12 and A-to-D scaling amplifier A2U18.

4-3.4 Level Setpoint. The output of digital-to-analog converter (DAC) A2U4 is a current proportional to the binary number at the DAC's digital inputs (pins 4 to 13) and to the analog voltage at its reference input (pin 15). A2U4's most significant bit indicates the sign of the RF output, and its nine remaining bits set the power output of the 1900B. Resolution is 0.05 dB. With the aid of a feedback resistor within the DAC, A2U5A converts A2U4's output current to a voltage. A2U5A's output, the setpoint voltage, is scaled at +5.00V +0.1953125 V/dBm.

4-3.5 Summing Amplifier A2U5B. A2U5B sums the setpoint voltage from A2U5A, the AM signal from A2U6B, and the temperature compensation voltage from the A9 Heatsink Assembly, to create the V(set) voltage which is applied to the loop's error amplifier. A2R2 and A2R3 offset and scale

A2-U5B's output to +0.0857V -0.200 V/dBm -0.035 V/degree C.

4-3.5.1 External AM Input. A signal applied to J7 on the rear panel may be used to amplitude-modulate the RF output. A2U6A and A2U6B reduce the external signal's scaling from +1.0 V/dB to +0.2 V/dB. A2CR2 and A2CR3 protect against excessive input levels, and A2R9 calibrates the circuit.

4-3.5.2 Temperature Compensation. The level control loop uses the voltage from directional detector U2 as a measure of the RF output, operating so as to keep the detector voltage constant for any particular power level commanded by the operator. However, even at a fixed frequency and output level, the detector's output voltage varies with changes in temperature. Over 0°C to +50°C the RF level would therefore change about 3.5 dB unless some form of temperature compensation were used. A circuit on the A9 Heatsink Assembly produces a voltage which is summed by A2U5B with the setpoint voltage from A2U5A so that the setpoint for any particular power level changes with temperature so as to reduce the variation to about 0.5 dB.

4-3.5.2.1 This temperature compensation circuitry remains active when external ALC is selected as it is assumed that the 1900B and the external detector will be at similar temperatures. Since no detector diode is present when manual level adjust is used, the circuit is configured so that under such conditions the temperature compensation has no effect on the RF output level.

4-3.6 Error Amplifier A2U12. A2U11A applies the V(dBm) signal from log amp A2U10 to the input of error amplifier A2U12 through either A2R27 or A2R29, depending on the state of the INT/~EXT ALC control line. A12R2 sets loop gain for the external ALC detector, while A2R29 sets loop gain for the internal ALC detector. A2U12's second input is the V(set) voltage from A2U5B.

4-3.6.1 Error Amplifier Operation. A2U12's non-inverting input is at ground. If the V(dBm) and V(set) voltages are equal in magnitude and opposite in polarity, A2U12's inverting input is at the same potential as its non-inverting input; therefore, the amplifier's output voltage will not change.

4-3.6.1.1 If an undesired increase in RF level occurs, the V(dBm) voltage goes negative and A2U12's output will go positive; and if an undesired decrease in RF level occurs the V(dBm) voltage goes positive and A2U12's output goes negative. Since A2U12's output voltage eventually sets the sweeper's RF level, this signal causes the V(dBm) voltage to change as appropriate until it again cancels out the V(set) voltage.

4-3.6.1.2 Similarly, if a request for an increased RF level occurs, the V(set) goes positive, A2U12's output goes negative, and the loop responds by causing the V(dBm) voltage to become more negative; and if the V(set) voltage goes more negative the output of A2U12 goes positive and the V(dBm) voltage will become more positive.

4-3.7 CLOSING THE ALC LOOP.

4-3.7.1 Leveler Driver Inputs. When

manual level adjust is used, the Setpoint voltage from A2U5A is applied to A2U12 through A2U11B, which also places A2R35 in A2U12's feedback path and permits A2R32 to provide a DC offset current. When internal or external ALC is selected, A2U12's output is applied through A2U11B to the input of A2U13. Here the MANUAL/~AUTO control line is LO; feedback for A2U13 is not through A2R35 but instead through the remainder of the leveling loop.

4-3.7.2 Leveler Driver A2U13. The signal from A2U13 controls the sweeper's RF output level. A2U13 inputs its input signal from error amplifier A2U12 or from the setpoint voltage generator A2U5A. As the signal from A2U12 goes more positive when more RF power is required and more negative when less RF power is required, A2U13's output goes less positive for more power and more positive for less power. A2U13's output is applied through A2R34 and A2J1 to the modulation input of leveling module U1.

4-3.7.3 System Interaction. The RF output from the YIG oscillator is applied to the input of leveling module U1, which consists, in part, of several PIN diodes placed across a transmission line. The voltage from A2U13 controls the module's RF output level, which in internal or external ALC is then applied to a detector diode whose -C output signal is applied to A2J2 or A2J3 to determine the V(dBm) voltage. This closes the ALC loop.

4-3.8 RF Muting Circuits.

4-3.8.0 The instrument's RF output may be greatly attenuated upon command. The RF output is also muted between sweeps, and may also be muted by the application of an external signal at rear panel J10.

4-3.8.1 RF Output Not Muted. If an RF signal is to appear at the output connector, the RF MUTE/~ON signal is LO. Unless the RETRACE input or the CHOP input is HI, A2Q1 is off and A2Q2's collector is at -15V. Under these conditions A2CR8 is reverse-biased and has no effect on the current into the diodes in the leveler module.

4-3.8.2 RF Output Muted. If RF MUTE/~ON, RETRACE, or the CHOP input is HI, A2Q1 turns on. This causes A2Q2 to turn on; A2Q2's collector rises to +15V, A2CR8 conducts, and about 15 mA flows through A2R37 and the PIN diodes in the leveler module, bringing them to a low-impedance state and decreasing the module's RF output.

4-3.8.3 Disabling Mute-Upon-Retrace. When desired, the user may disable the mute-upon-retrace function by removing A2CR9. This has no adverse effect on the instrument.

4-3.9 Analog-To-Digital Converter A2U16.

4-3.9.0 This circuit permits the CPU to determine the sweeper's actual RF output level. The CPU reads, stores, formats, and displays this data.

4-3.9.1 Analog Processing. The V(dBm) signal representing the sweeper's RF output power is processed by A2U18 and applied to the input of A-to-D converter A2U16. A2U18's output is scaled at 0V -0.1 V/dBm. A2R53 and A2R56 calibrate this voltage.

4-3.9.2 Analog-to-Digital Conversion. A2U16's outputs are a multiplexed BCD (binary-coded-decimal) representation of the polarity and magnitude of the applied voltage, and thus describe the instrument's output power in dBm when the internal ALC mode is selected. If the gain and offset adjustments for an external detector are properly set, U16's outputs will also reflect the RF power at the external detector when the external ALC mode is selected. A2U17 provides a regulated -5V supply required for operation of A2U16.

4-3.9.3 A-to-D Microprocessor Interface. A2U16 completes several conversion cycles each second; when a conversion is complete its EOC (End Of Conversion) line goes HI. If internal or external ALC has been selected the microprocessor receives an interrupt request via the PIA and then sets A2U16's DU (Display Update) input high. After the CPU has read the desired information, the DU line is set low again.

4-3.9.3.1 A2U16's four DS outputs go sequentially high to identify which digit's data is present in BCD format at the device's Q outputs. The most significant digit also contains polarity information. The least significant digit is scaled at 0.01 dB and is ignored by the CPU.

4-3.10 V(f) AMPLIFIER A2U14.

4-3.10.0 The A4 Frequency Control PCB generates a Main Tune voltage scaled at +0.59 V/GHz of output frequency. A2U14 processes this voltage to create an output scaled at 0.0V +1.0 V/GHz. A2Q3 buffers the amplifier's output while A2R41 and A2R45 provide calibration. Since the V(f) voltage may exceed +18V in certain versions of the 1900B, A2U14 operates from the +24V supply and a -5V supply provided by A2U15.

4-3.10.1 The V(f) output appears at rear panel connector J1. The minimum tolerable load is 150 ohms, though the output is only specified for loads of 1k or more; for best results loads of 2k or higher should be used. A2R48 is intended to fail (open) in the event of a prolonged short circuit.

4-3.11 Reference Voltages. A2U19 produces a +10.00V output which is buffered by A2U20A and inverted by A2U20B to produce +10.00V and -10.00V references for the PCB. Noise reduction on these voltages is provided by A2R61 and A2C45.

4-4. A3 RAMP AND MARKER PCB Assembly, 083418.

4-4.0 The A3 Ramp and Marker PCB generates a precision +10V ramp which is used by the A4 Frequency Control PCB to sweep the 1900B's output frequency, and contains circuitry used to generate the frequency markers.

4-4.1 CPU Interface.

4-4.1.0 PIA A3U1's two main ports hold data to set the sweep time and control a number of sweep-related functions. The PIA detects the rising and falling edges of the GATE signal from A3U11B and generates an interrupt request when either edge occurs, informing the CPU that a sweep has just begun or has just been completed. The CPU, in turn, uses this information to control the state of SWEEP annunciator on the front panel.

4-4.1.1 PIA A3U2's two main ports hold data to define the frequency of the next active marker (data for the first active marker is loaded into A3U2 prior to the start of a sweep). When the marker frequency is reached the LOAD NEXT MARKER (LNM) signal goes HI and the PIA generates a non-maskable interrupt request. The CPU responds by loading data for the next active marker into the PIA.

4-4.2 Ramp Generator.

4-4.2.0 This circuit generates a 0V to +10V ramp used by the A4 PCB to sweep the 1900B's RF output frequency. The ramp generator consists of a programmable voltage source, a voltage-to-current converter, an integrator, a limit detector, and control logic.

4-4.2.1 Mathematics of Ramp Generator Operation. Assuming a constant input current, the change in an integrator's output voltage as a function of time, DeltaV, is defined by:

$$DeltaV = \frac{-I*T}{C}, \qquad (Eq.1)$$

Where I is the integrators input current, T is the period during which this current is applied, and C is the integrating capacitor (A3C9).

4-4.2.1.1 DAC A3U5 is used as a digitally-controlled feedback resistor for amplifier A3U6B. Vdac, the amplifier's output voltage, is therefore defined by:

$$Vdac = \frac{-4096*Vin}{N}, \qquad (Eq.2)$$

where Vin is the voltage at A3U5 pin 18 and N is the digital number at A3U5's logic inputs. A3U6B's output, which ranges from 0V to -10V, is applied to integrator A3U6A through the A3R6 and A3R7, called for convenience Rin. Ohm's law states that:

$$I = \frac{Vdac}{Rin}. \qquad (Eq.3)$$

Substituting this equation for I in equation 1, we can write:

$$DeltaV = \frac{-Vdac*T}{Rin*C}. \qquad (Eq.4)$$

Since we are here concerned with the time required for DeltaV to make a particular voltage change, equation 4 is now rearranged as follows:

$$T = \frac{-DeltaV*Rin*C}{T}. \qquad (Eq.5)$$

Next, combining equations 2 and 5, we can write:

$$T = \frac{-DeltaV*C*Rin*N}{4096*Vin}, \qquad (Eq.6)$$

which demonstrates that the time for the integrator's output to change by any particular DeltaV is directly proportional to the digital number N.

4-4.2.2 Limits on Performance. With a 12-bit DAC such as A3U5, N can range from 0 to 4095. In the 1900B,

values from 2 to 4000 are used, corresponding to sweep times of 10 mS to 20 seconds. Errors in the DAC's accuracy affect the accuracy of the sweep time but have no adverse effect on sweep linearity. A3C9 uses a metallized polycarbonate dielectric for the best available compromise of leakage, dielectric hysteresis, capacitance stability over temperature and over applied voltage, physical size, and cost. Should replacement be necessary, only an exact duplicate should be used.

4-4.2.3 Integrator Reset Switch A3Q2. FET A3Q2 is the integrator's reset switch. When turned on at the end of a sweep, the FET operates in the constant-current mode until the voltage across the integrator capacitor A3C9 drops to +2V, after which the FET acts as a fixed resistor. Integrator reset time is typically 782 μS.

4-4.2.4 Sweep Halt Switch A3Q1. The sweep may be halted by an external signal. A HI at A3(17) turns on A3Q5, which in turn causes A3Q4 to turn off. A3Q4's drain rises to +15V, A3Q1 turns off, and A3U6A no longer has a source of input current. The integrator's output voltage remains constant until the gate of A3Q5 is again at ground, at which time the sweep will continue. A3R8 nulls A3U6A's input offset, while A3CR1 prevents the integrator's output from going sufficiently negative to bias A3Q2 improperly.

4-4.2.4.1 There is no limit on the duration of the external Halt signal; however, the sweeper's frequency drift characteristics are not specified. When the sweep has been halted, the integrator output should drift less than 0.2 mV per second, corresponding to a typical output frequency change of about 200 kHz.

4-4.2.5 +10V Ramp Buffer. A3U3A and A3Q3 buffer the sweeper's internal or external ramp voltage. The buffer's output is applied to rear panel connector J2. The minimum tolerable load is 150 ohms, though the output is specified only for loads of 1k or more; loads of 2k or higher provide best results. A3R47 is intended to fail (open) in the event of a prolonged short circuit at the output.

4-4.3 SWEEP CONTROL LOGIC.

4-4.3.0 Before the start of a sweep the integrator's output voltage is 0V. When the sweep starts the voltage from the integrator increases linearly until it reaches +10V. When this voltage is exceeded, the end-of-sweep detector resets the integrator to terminate the sweep.

4-4.3.1 Conditions Before Sweep Start. Flip-flop A3U11A/A3U11B is set so that A3U11A's output (~SWEEP) is HI and A3U11B's output (GATE) is LO. If a sweep is to be permitted, the SWEEP ENABLE/~ABORT line from A3U1 is HI; otherwise, this line is held LO by A3U1.

4-4.3.1.1 If SWEEP ENABLE/~ABORT is LO, flip-flop A3U11A/A3U11B is reset, the integrator is reset through A3Q2, and any existing sweep is immediately terminated. This allows immediate selection of the CW mode regardless of the selected sweep time.

4-4.3.2 Conditions During A Sweep. A trigger from A3U10 causes A3U8B to generate a 4 μS pulse which sets

flip-flop A3U11A/A3U11B. The output of A3U11A (~SWEEP) goes LO and the output of A3U11B (GATE) goes HI.

4-4.3.2.1 When ~SWEEP goes LO, A3U12 changes states, turning A3Q2 off. Unless a halt has been commanded a current is now applied to the input of the integrator, and A3U6A's output begins the sweep ramp.

4-4.3.2.2 The GATE signal is applied to A3U1. When GATE goes HI, the PIA informs the CPU that a sweep has just been started. The CPU responds by causing the SWEEP annunciator on the instrument's front panel to light.

4-4.3.3 Conditions at End Of Sweep. The integrator's output voltage is applied to the input of comparator A3U7. When this ramp just exceeds the +10.00V reference, the comparator's output goes HI to create the EOS (END OF SWEEP) pulse. A3C49 provides AC-coupled hysteresis to lengthen the output pulse from the comparator and to prevent retriggering of the comparator by noise.

4-4.3.4 Actions During Retrace. The EOS pulse triggers A3U8A, which produces a 9 mS ~RETRC (NOT RETRACE) pulse which is inverted by A3U11C and applied to the A2 PCB, where it mutes the RF output during retrace. The circuit configuration prevents a new sweep from being triggered during the retrace period.

4-4.3.4.1 ~RETRC resets flip-flop A3U11A/A3U11B, setting ~SWEEP to HI and GATE to LO, the state the flip-flop assumed prior to the start of the sweep. A3U12's output switches from -15V to 0V, turning on A3Q2 and resetting the integrator. The transition on the GATE signal causes PIA A3U1 to inform the CPU that the sweep has ended; the CPU responds by turning off the SWEEP annunciator on the front panel.

4-4.3.4.2 During the retrace period the YIG oscillator must return to its initial starting frequency, which in turn requires that the current through the Main Tune coil be reduced to the initial value. The time required to collapse the current in the coil is determined by the coil's inductance, the current through it, and the damping circuit on the A9 Heatsink PCB, and is typically about 7.8 mS.

4-4.4 Sweep Trigger Circuits.

4-4.4.0 The 1900B provides an automatic recurrent sweep. A sweep can also be initiated when a front-panel switch is pressed, upon the occurrence of an externally-generated signal, and upon a transition of the AC power line voltage.

4-4.4.0.1 Under CPU control, multiplexer A3U10 selects the desired trigger source. The signal at the selected input appears at A3U10's Y output; its positive-going edge triggers monostable multivibrator A3U8B, which in turn generates a 4 µS negative-going pulse that sets flip-flop A3U11A/A3U11B so that ~SWEEP is LO and GATE is HI, starting a sweep as described above.

4-4.4.1 Automatic Trigger. In the "auto" sweep mode, the 1900B provides automatic recurrent sweeps without the need for any external stimulus. Here the signal at A3U10's D0 input is selected; the negative-going pulse from A3U8A that occurs at the end of each sweep triggers the following sweep as described

above.

4-4.4.1.1 As it cannot be guaranteed that a sweep is in progress when the recurrent sweep mode is selected, the CPU forces one initial trigger whenever this sweep mode is first selected. Here the CPU selects A3U10's D6 input, then its D5 input, causing a LO-to-HI transition that triggers A3U8B. A3U10's D0 input is then selected to permit recurrent sweep.

4-4.4.2 AC Line Trigger. An AC signal from power transformer T1 is applied to the gate of A8Q1. When its gate is at zero volts the FET is off; conversely, when its gate is positive the FET turns on. A8Q1's output is applied through A3(15) to Schmitt trigger A3U9, resulting in two complimentary signals at the D3 and D4 inputs of A3U10. This permits either input slope to trigger the sweep, though the positive-going edge is initially selected each time the Line trigger mode is first entered.

4-4.4.2.1 A second use of the trigger switch causes the CPU to cause A3U10 to select the negative-going input as the sweep trigger signal; further use of the switch continues this process, resulting in alternate selection of the two input edges.

4-4.4.3 External Trigger. An external TTL-compatible trigger is applied through A3(14) to A3U9, resulting in two complimentary signals at the D1 and D2 inputs of A3U10. As with the Line trigger mode, the input's positive-going edge is selected each time this trigger mode is first entered, and the selected slope alternates upon further use of the switch.

4-4.4.4 Manual Trigger. In this mode, the CPU causes A3U10 to produce a single output pulse each time the front-panel manual trigger switch is pressed. As with recurrent sweep, the CPU selects A3U10's D6 input, then its D5 input, causing a LO-to-HI transition to trigger A3U8B.

4-4.5 External Sweep.

4-4.5.0 An external signal applied through the External Sweep input J3 may be used in place of the internal ramp when desired. A3U3B buffers this signal, while A3R4, A3CR2, and A3CR3 protect the buffer from excessive input voltages. A3W2 makes the correct circuit connection and A3W3 informs the CPU that the external sweep mode has been selected.

4-4.5.1 Purpose of A3W3. When A3W3 is installed. the CPU disables the internal sweep generator. If this were not done, the sweep generator would remain in operation and the RF output would be muted each time the sweep was reset, causing undesired muting of the RF output.

4-4.5.2 Limits on External Sweep. The slew rate of the external signal may not exceed 1 volt/millisecond. Since the noise level, amplitude, and linearity of the external signal are not under Systron Donner's control, the residual FM and sweep specifications can not be guaranteed.

4-4.5.2.1 Function of the marker circuitry and correct operation of the SWEEP annunciator depend in part on the GATE signal from A3U11B. As this signal has no relation to an

external sweep, these functions will not operate correctly when the external sweep mode is selected.

4-4.6 Marker Circuits.

4-4.6.0 The 1900B creates up to five distinct marker outputs. The CPU stores each of these marker frequencies and determines whether they are within the limits of the existing sweep. Ignoring any marker frequencies not within that range, the CPU loads data representing the lowest active marker frequency into A3U2 at the start of each sweep. As each marker occurs, the CPU loads the frequency value of the next valid marker into A3U2.

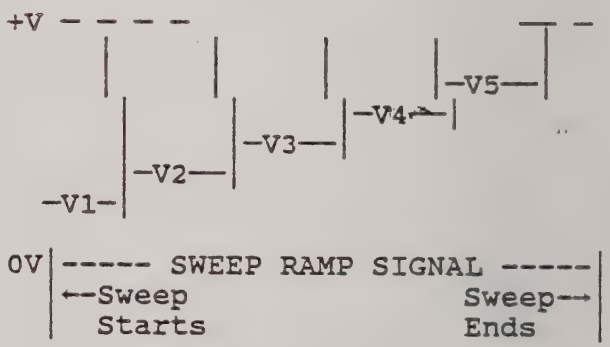
4-4.6.1 Marker Voltage Generation. The data from A3U2 are applied to DACs A3U13 and A3U14, whose output currents are transformed into voltages by A3U15B and A3U15A. A3U16 sums these two voltages to produce an output scaled at +0.59 V/GHz. A3R22, A3R25, and A3R28 calibrate the marker voltage.

4-4.6.2 Marker Comparator A3U17. A3U17 compares the marker voltage from A3U16 with the Main Tune voltage created on the A4 PCB. Both signals are scaled at +0.59 V/GHz. When the Main Tune voltage has risen to become just equal to the marker voltage, the output frequency has reached the frequency of the marker. When this occurs A3U17's output goes LO to create the ~MPI (NOT MARKER PULSE INITIATE) signal. A3C50 suppresses noise which might otherwise cause extraneous generation of ~MPI signals.

4-4.6.3 Marker Monostable A3U18A. A3U18A produces a 1-mS pulse upon the occurrence of each ~MPI. This pulse is converted by the A11 PCB to the desired marker output configuration.

4-4.6.4 Marker Interface With CPU. A3U18A's Q output is applied to A3U2's CA1 input; when this line goes HI the PIA interrupts the CPU, which responds by loading A3U2 with data to produce the maximum possible voltage. As this data is applied to A3U13 and A3U14, the voltage at A3U16's output rises toward 15 volts. Next, the CPU loads the PIA with data for the next valid marker frequency, and the output of A3U16 decreases to the appropriate new voltage. With five active markers, the signal at A3TP4 would resemble the waveform below.

Figure 4-1 Marker Voltage at A3-TP4. (formal art to be inserted).



4-4.7 Reference Voltages.

4-4.7.1 A3U20 produces a +10.000V output which is buffered by A3U21A and inverted by A3U21B to produce the +10.00V and -10.00V references used by the A3 PCB. These two references are filtered by A3R32 and A3-C45.

4-5 A4 FREQUENCY CONTROL PCB Assembly, 083419.

4-5.0 The A4 Frequency Control PCB sets the RF output frequency by controlling the current which flows through the YIG oscillator's Main Tune coil.

4-5.1 Noise and Residual FM. Noise was a matter of great concern during the design of the A4 PCB. The reason for this concern becomes obvious when one considers that a typical YIG oscillator has a tuning sensitivity of 20 MHz/mA: a one microampere noise current in the YIG's Main Tune coil would therefore cause 20 kHz residual FM. A 1 μA current develops 10 μV across sense resistor A4R56, and only 5 μV in units operating above 12 GHz, when A4R57 is also present. To minimize noise and error, all critical signal nodes are guarded, and a single-point ground system minimizes possible offset voltages.

4-5.2 Basic Concept. Regardless of the operating mode indicated by the front panel, the internal operation of the 1900B is always the same. A voltage proportional to the lowest frequency of the sweep is created, and a ramp with an amplitude proportional to the desired sweep width is summed with this DC voltage to determine the output frequency. This can be considered as a sort of START/DELTA sweep mode as opposed to a START/STOP or CENTER/DELTA mode. The CW mode then becomes a special case where DELTA is zero.

4-5.3 CPU Interface. PIA A4U1's two main ports are used as outputs and hold data setting the CW or start frequency. An additional line is used to enable a noise filter when the CW or phaselock operating mode is selected. PIA A4-U2's two main ports are used as outputs and hold data setting the size of the frequency sweep.

4-5.4 Frequency Setpoint Voltages. The data at the logic inputs of DACs A4U5 and A4U6 set the lowest RF output frequency. Each DAC produces an output current proportional to its digital input and the voltage at its REF input. A4U7A and A4U7B convert these currents into voltages. Similarly, the data at the logic inputs of A4U8 and A4U9 set the frequency change which is to occur, and A4U10A and A4U10B convert the DACs' output currents into voltages.

4-5.4.1 DAC References. The REF inputs of A4U5 and A4U6 are supplied by the +10.00V reference, while those of A4U8 and A4U9 are supplied by the +10V ramp from the A3 PCB when A4W1 is installed, or to the +10.00V reference when A4W2 is installed. A4W2 permits temporary substitution of the ramp voltage with the +10.00V reference during initial instrument calibration.

4-5.4.2 Summing Amplifier A4U15. This unbalanced differential amplifier sums together the outputs of A4U7A, A4U7B, A4U10A, and A4U10B. A4R1, A4R5, A4R10, and A4R15 calibrate these four voltages while A4R28 and (if necessary) A4R54 or A4R55 compensate for any frequency offset in the YIG oscillator's tuning characteristics. A4U15's output is scaled at +0.59 V/GHz with a DC offset appropriate to the particular YIG oscillator being used.

4-5.4.3 Residual FM Filter. When a sweep mode is selected, the CW/$\overline{\text{SWEEPMODE}}$ control signal from A4U1 is LO. This sets A4U3's output to -15V; A4CR1 conducts through A4R8 and FET switch A4Q2 is off. Under

these conditions, A4C28 has no effect on A4U15's bandwidth. In the CW mode, however, the CW/~SWEEPMODE control signal is HI and A4U3's output is +15V; A4CR1 does not conduct, the source and gate of A4Q2 are at the same voltage, and A4Q2 is on. This places A4C28 across A4R4 and drops the noise on U15's output by a factor of about 3:1, equivalent to a typical residual FM of 5 to 10 kHz peak.

4-5.4.4 Main Tune Voltage Output From A4U11B. The voltage at A4U15's output is scaled to +0.59 V/GHz but has a DC offset voltage appropriate to the YIG oscillator installed in the instrument. A4U11A amplifies the offset voltage across A4R19 by 3.43 and applies it to A4U11B's inverting input. At the same time, A4U15's output is applied to A4U11B through A4R49 and A4R50. The net result is to make A4U11B's output independent of the DC offset necessary for the YIG, markedly simplifying marker and Vb calibration. A4U11B's output is +0.59 V/GHz and is called the Main Tune voltage.

4-5.5 Error Amplifier A4-U12. The frequency-determining current through the YIG oscillator's Main Tune coil also flows through A4R56 (and A4R57 in units operating above 12 GHz). The voltage across the sense resistor(s) is applied to the inverting input of the error amplifier, A4U12. A portion of A4U15's output is applied to A4U12's non-inverting input through A4R22.

4-5.5.1 Circuit Operation. A4U12's output controls the voltage-to-current converter that sets the current through the YIG oscillator's Main Tune coil. If a higher frequency has been commanded, A4U15's output goes more positive, causing A4U12's output also to go more positive. This voltage change causes the current through the coil to increase, which, in turn, raises the output frequency. As the tuning current flows through A4R56 (and A4R57 when installed), the voltage across the resistor(s) rises until it equals the voltage at A4U12's non-inverting input. Similarly, a decrease in the control voltage causes the tuning current to decrease, lowering the output frequency.

4-5.5.2 Circuit Calibration. A4R24 adapts the circuit for YIG oscillators of many different tuning sensitivities. The scaling of the error amplifier's two inputs depends on the tuning sensitivity of the YIG oscillator, and is typically +0.5 V/GHz. A4R23 calibrates the circuit for proper control of the RF output frequency.

4-5.6 Reference Voltages. A4U13 produces a +10.000V output which, after filtering by A4R37 and A4C22, is buffered by A4U14A to produce the +10.00V reference. Precision resistor network A4RN1 and A4U14B produce the -10.00V reference. Beta multiplier A4Q1 is used to further reduce the noise on these two critical voltages.

4-5.7 Beta Multipliers. A4Q5 and A4Q6 provide low-noise +15V and -15V power supply voltages for the A4 PCB, thereby minimizing the residual FM on the sweeper's RF output signal.

4-6 A5 FRONT PANEL DRIVER PCB Assembly, 083415.

4-6.0 The A5 Front Panel Driver PCB works in conjunction with the A6 Switch And Display PCB to permit

manual control of the instrument and to display most operational parameters. Though display encoding and switch closure interpretation are performed by the A1 CPU PCB, the circuitry on the A5 PCB requires only minimal attention from the CPU.

4-6.1 Keyboard and Display Interface. A5U1 detects switch closures in as many as 64 switches in an 8x8 matrix, and is able to store and multiplex data for up to 16 eight-element displays. The rate at which the keyboard and display are scanned is set by the CPU's 1-MHz E-clock and a programmable divider internal to A5U1.

4- 6.1.1 Scan Lines. A5U1 produces four SCAN LINE outputs SL3 to SL0. These signals, generated by a four-bit binary counter within A5U1, determine the destinations of all display data and aid in the determination of the location of any switch closures on the A6 PCB.

4-6.1.2 General Timing Clock. The signal on SL3 is buffered by A5U4A and A5U4B, then applied to the CB1 input of PIA A5U14. Each time a positive transition occurs at its input, the PIA generates an IRQ which is used by the CPU for general timing purposes.

4-6.2 Keyboard Scanning. Scan line signals SL2, SL1, and SL0 drive the control inputs of decoder A5U3, which produces eight mutually-exclusive active-LO outputs. Five of these outputs are coupled to a 25-switch keyboard arranged in a 5x5 matrix and located on the A6 PCB.

Each ~KEYBOARD STROBE line (~KS4 to ~KS0) drives one switch column, while each switch row is connected to one of A5U1's RESPONSE LINE (RL) inputs; the three remaining RL inputs are not used. The RL inputs have internal pullups, and A5U1 incorporates debouncing techniques to avoid false key status reports.

4-6.2.1 Events Upon Switch Closure. When a switch is closed, the response line associated with it goes LO only when the keyboard strobe associated with the same switch is LO. By keeping track of its SL outputs and RL inputs, A5U1 can determine whether or not a switch was closed and, if so, where in the matrix the closure occurred. Upon a switch closure, A5U1's IRQ OUT goes high. This signal drives the CA1 input of A5U14 and causes the PIA to generate an interrupt request. When responding to the interrupt, the CPU first interrogates A5U1 to determine which switch was pressed, then resets the interrupt registers on A5U1 and A5U14.

4-6.3 Display Drivers. The scan lines are decoded by A5U5 and A5U6 to create sixteen mutually-exclusive active-LO outputs which drive the transistors in arrays A5U7 to A5U10, which in turn drive the anodes of sixteen separate LED numeric displays. A5U1 provides a ~BLANK - DISPLAY signal which disables the anode drivers until the logic levels of the Scan Lines and segment drivers are stable.

4-6.3.1 Display Data Storage. A5U1 stores sixteen bytes of data provided by the CPU. Each byte is presented in turn to the output port (A3 to A0, B3 to B0) and applied to peripheral driver A5U2 and FET A5Q1. The outputs of these two devices are applied to the cathodes of the various LED annunciators and numeric

displays on the A6 PCB.

4-6.3.2 Alphanumeric Characters With 7-Segment Displays. As the CPU has total control over the data held in A5U1, the front panel is able to display numerous alphabetic characters as well as the usual digits 0 to 9.

4-6.4 Shaft Encoder. The shaft encoder is connected to the knob on the front panel. In conjunction with A5U11, A5U12, A5U13, and the CPU, the shaft encoder determines the direction and extent of any rotation applied to the knob.

4-6.4.1 Shaft Encoder Outputs. The shaft encoder generates two output pulses, Phase A and Phase B, whose phase relationship depends on the direction in which the knob is turned. During clockwise rotation, the shaft encoder's Phase A goes HI before Phase B. The reverse is true during counter-clockwise rotation.

4-6.4.2 Clockwise Rotation. During clockwise rotation, Phase A ges HI before Phase B, placing a HI at the D input of A5U11A. Continued rotation causes Phase B to go HI, clocking A5U11A and transferring the HI at its D input to its Q output. This places a HI at the Up/~Down inputs of binary counters A5U12 and A5U13. Simultaneously, the LO-to-HI edge of Phase B clocks A5U11B, causing its Q output to change state; if this output was LO prior to the Phase B change it will now go HI. After a delay determined by A5R3 and A5C9, the CLOCK inputs of A5U12 and A5U13 go HI, causing their stored count to increment. HI-to-LO transitions on the CLOCK inputs of the two binary counters have no effect. Continued clockwise rotation of the shaft encoder will cause Phase A to go LO, then Phase B; neither of these events affects A5U11A or A5U11B. The the whole process repeats as long as rotation continues.

4-6.4.3 Counter-Clockwise Rotation. Counterclockwise rotation of the knob operates similarly, save that Phase A goes LO before Phase B goes HI; thus, the Up/~Down inputs of A5U12 and A5U13 are LO, and positive-going edges on the counters' CLOCK inputs will cause the count stored therein to decrement.

4-6.4.4 CPU Interface. The outputs of the two counters are applied to Port B of PIA A5U14. If the shaft encoder is supposed to be active, the CPU reads the PIA port upon each IRQ caused by the CHECK signal from A5U4B. The CPU then compares this new data to the previous data, and uses the difference between the two values to determine the direction and amount of rotation which has been applied to the shaft encoder. This information is then used to modify the selected parameter. System software accounts for overflow and underflow of the two counters.

4-7 A6 SWITCH AND DISPLAY PCB Assembly, 083414.

4-7.0 The A6 Switch and Display PCB mounts the LED displays, annunciators, and switches necessary for manual control of the 1900B.

4-7.1 Keyboard Scanning. The 25 switches are arranged in a matrix of five rows by five columns. Keyboard and display interface A5U1 generates control signals which scan the rows of this matrix. If a switch is closed, the scanning signal is coupled to the appropriate column out-

put, where it is read by A5U1.

4-7.2 Display Drivers. A5U1 provides multiplexed data to segment drivers on the A5 PCB. These segment driver outputs drive the cathodes of the displays and annunciators on A6. Additional circuitry generates sixteen mutually-exclusive anode drive signals for these LEDs.

4-8 A7 PHASE LOCK PCB Assembly, 083416.

4-8.0 The A7 Phase Lock PCB contains most of the circuitry required to phase lock the instrument's RF output frequency to an internal 100 MHz reference. Microwave assembly A7A1 is part of the A7 PCB.

4-8.0.1 Instruments not equipped with the Phaselock option are not furnished with an A7 assembly. On such instruments pins (R) and (T) on the A10 Motherboard are connected together by appropriate resistors so that an external FM signal may be applied directly to the FM coil driver circuitry on the A9 Heatsink Assembly.

4-8.1 External FM Operation. Under control of the CPU, A7Q4 drives the coils of relays A7K1 and A7K2. Unless Phaselock is selected, A7K2's contacts are closed and A7K1's contacts are open, permitting an FM modulation signal at rear panel connector J8 to be applied to the voltage-to-current converter on the A9 Heatsink Assembly.

4-8.1.1 External FM Sensitivity. This is nominally -6 MHz per volt and is determined by A7R31, the FM amplifier on the A9 Heatsink Assembly, and the tuning sensitivity of the YIG oscillator's FM coil.

4-8.2 A7A1 Sampler Driver Assembly, 083797.

4-8.2.0 This microwave assembly contains a crystal-controlled 100 MHz oscillator, a 100 MHz power amplifier, and a sampling mixer.

4-8.2.1 100 MHz Oscillator and Buffer. A7A1Q1's frequency of oscillation is determined by fifth-overtone crystal A7A1Y1 and A7A1C3. Matching and feedback are provided primarily by A7A1C1, A7A1C2, and A7A1L2, while A7A1Q2 buffers the oscillator's output. Heater A7A1R9 maintains A7A1Y1 at about +65C, thus improving frequency stability.

4-8.2.2 100 MHz Power Amplifiers. Integrated amplifier A7A1U1 boosts the 0.5 VPP signal at its input to about 2.0 to 2.6 VPP. A7A1C4 and A7A1L7 tune the amplifier's input, while A7A1C15 and A7A1L8 tune its output; A7A1L4 is an RF choke. RF power transistor A7A1Q3 further increases the level of the 100 MHz signal to 5.0 to 5.1 VPP (about +20 dBm).

4-8.2.3 Sampling Mixer. The sampling mixer (sampler) generates a large and indefinite number of harmonics of its 100 MHz LO signal. Each of these harmonics is mixed with the signal applied to the sampler's RF input, here the Sweeper's RF output frequency. As the usable bandwidth of the IF output is about 4 MHz, most of these sum and difference products are greatly attenuated, and the sampler produces an output only when the RF input is close to an integer multiple of the 100 MHz LO.

4-8.3 IF Processing Circuitry.

4-8.3.0 These circuits, in conjunc-

tion with the sampling mixer and the FM coil driver circuits on the A9 Heatsink Assembly, form the remainder of the phase-locked loop.

4-8.3.1 Video Buffer. The sampler's IF output is applied to the input of a very-low-capacitance video buffer formed by A7Q2A and A7Q1. The buffer's output is applied to the input of differential amplifier A7U1, while A7Q2B and A7Q3 provide a DC reference voltage equal to the output of the video buffer. A7R32 provides a DC offset to compensate for the DC offset inherent in the diodes used to fabricate the sampling mixer: A7W1 or A7W2 is installed to set the polarity of this offset.

4-8.3.2 Error Amplifier A7U3. When Phaselock mode is selected, A7U3's output is connected through A7R29 and A7K1 to the input of the FM coil driver on the A9 Heatsink Assembly. A7U3's output voltage controls the current through the YIG oscillator's FM coil and thus is able to alter the sweeper's RF output frequency.

4-8.3.3 Search Amplifiers. A7U2A and A7U2B are configured as Schmitt triggers with state change limits of +10V and -5V for A7U2A, and -10V and +5V for A7U2B. The voltages at these amplifiers' non-inverting inputs are determined by the amplifiers' output voltages, the voltage from the error amplifier, and the values of the input and feedback resistors (A7R22 and A7R21; A7R26 and A7R19).

4-8.3.4 Search Function. If the Phaselock mode is selected, the YIG oscillator is tuned to the integer multiple of 100 MHz nearest the existing CW frequency. Under such circumstances U1's output is close to zero volts and the voltage at A7U3's output drifts toward either +15V or -15V, depending on the DC offsets at the input to the error amplifier.

4-8.3.4.1 As the voltage from A7U3 affects the current through the YIG's FM coil, the YIG's RF output frequency changes. If this change does not result in an RF output frequency which is an exact integer multiple of 100 MHz, A7U3's output continues to drift until it reaches either +10V or -10V. If this drift was positive, A7U2A's output changes from -15V to +15V and A7CR1 conducts, while A7U2B's output remains positive. Similarly, if the drift was negative A7U2B's output changes from +15V to -15V and A7CR2 conducts, while A7U2A's output remains negative. This change causes A7-U3's input to move in the direction opposite its initial drift until the search amplifier again changes state and its diode no longer conducts; this occurs at a -5V or +5V level from A7U3. When this occurs A7U3's input offset again causes its output to drift, and the cycle will repeat indefinitely.

4-8.3.5 Lock Acquisition. If the changing voltage from A7U3 should cause the RF output frequency to approach an integer multiple of 100 MHz, the sampler's IF output becomes significant. The sampler then produces a signal at a frequency equal to the difference between the RF frequency and the nearest integer multiple of 100 MHz. The phasing of this IF signal is such that, when it is amplified by A7U1 and A7U3, the YIG's frequency will change so as to bring the RF output frequency closer to an exact integer multiple of 100 MHz, and the loop locks.

4-8.3.5.1 The figure below shows the typical signal at the output of A7U1 as the YIG oscillator's frequency is swept through an exact integer multiple of 100 MHz.

Figure 2. IF Output at A7U1.
(Formal art to be inserted).

4-8.3.6 Loop Behaviour During Non--Phaselock Operation. When the Phaselock mode is not selected, the only function of the A7 PCB is to scale the FM modulation signal as appropriate for the YIG oscillator used in the individual instrument. Under such circumstance the search function is active, but since the search voltage is not connected to the YIG's FM coil it has no effect on the instrument's output frequency.

4-9 A8 POWER SUPPLY PCB Assembly, 083420.

4-9.0 The A8 Power Supply contains the rectifiers, filter capacitors, and most of the voltage regulators required for instrument operation.

4-9.1 Line Trigger Supply. An isolated transformer winding provides 2V RMS which is applied through A8CR9 to the gate of A8Q1. The FET converts this input to a logic-compatible signal at the AC line frequency. A8Q1's output is applied to the A3 Ramp and Marker PCB to provide a signal for the AC Line Trigger function.

4-9.2 Grounding. Proper grounding is essential for minimum residual FM. The transformer windings used for the +5V supplies are isolated from the windings used for the +15V, -15V, and +24V supplies. The center taps of these two windings are connected together at a single point on the A8 PCB. This point is the ground reference for all power supply regulators, and is connected to the chassis at a single point.

4-9.3 Regulated +5V Supplies. A8CR1 and A8CR2 rectify an AC voltage from T1 to produce +9.0V to +14.0V at 2.2A maximum. A8U1 and A8U2 each produce regulated outputs of +4.75V to +5.25V. A8U2 supplies the A5 and A6 PCBs, while A8U1 supplies the remainder of the instrument. Thermal constraints and noise considerations require two regulators.

4-9.4 Regulated +15V Supply. A8CR3 and A8CR4 rectify an AC voltage from T1 to produce +22.0V to +31.0V at 2.6A maximum. A8U3 produces a regulated +14.25V to +15.75V for most of the analog circuitry. The unregulated voltage from A8CR3 and A8CR4 is also used on the A9 Heatsink Assembly to provide the Main Tune supply and, when necessary, a Vb Supply for Gunn-diode YIGs.

4-9.5 Regulated -15V Supply. A8CR5 and A8CR6 rectify an AC voltage from transformer T1 to produce -18.0V to -26.0V at 0.4A maximum. A8U4 produces a regulated -14.25V to -15.75V for most of the analog circuitry.

4-9.6 Regulated +24V Supply. A8CR7 and A8CR8 rectify an AC voltage from T1 to produce +26.8V to +38.5V at 0.2A maximum. A8U5 produces a regulated +22.8V to +25.2V for the YIG

oscillator's heater and for the V(f) amplifier on the A2 ALC PCB.

4-10 A9 HEATSINK ASSEMBLY, 083421.

4-10.0 The A9 Heatsink Assembly contains a voltage regulator and current driver for the YIG oscillator's main tuning current, a current driver for the YIG's FM coil, a voltage regulator for an additional -5V supply required by some YIG oscillators, a voltage regulator to provide the Vb supply required by Gunn-diode YIG oscillators, and a circuit to compensate for temperature-related effects on the instrument's RF output level.

4-10.1 Regulated Main Tune Supply. As long the input to A9U3 is at least +3.2V, the regulator maintains 1.2V between its output and adjustment terminals (its case and pin 1, respectively), causing about 10 mA to flow through A9R19. As the adjustment terminal neither sources nor sinks a significant amount of current, this same current flows through A9R18. The voltage drop across the two resistors thus sets the regulator's output voltage, which is about +17.0V for most YIGs.

4-10.1.1 Regulator Protection and Filtration Circuits. A9CR2 protects A9U3 in the event of a short to ground at the regulator's input, while A9CR1 provides protection in the event of a short to ground at A9U3's output. A9C11 provides improved transient rejection and suppresses any tendency of the regulator to break into oscillation, while A9C9 is necessary due to the regulator's physical distance from the filter capacitors on the A8 PCB.

4-10.2 Main Tune Coil Driver A9Q3. The current through the YIG oscillator's main tune coil is determined by the A4 Frequency Control PCB. A control voltage is applied through A9R23 to the gate of A9Q3, whose source is returned to current sense resistor(s) A4R56 (and A4R57 for units operating above 12 GHz).

4-10.2.1 The main tune coil is placed between the FET's drain and the +17V supply. A9R20 and A9C10 are present to prevent A9Q3 from oscillating at RF frequencies during sweeps; A9C12 and A9R22 provide additional damping during retrace. A9R21 limits the discharge current so that the YIG has a retrace time of about 8 mS. A9CR3 prevents a large reverse voltage from being developed across the main tune coil during the retrace period.

4-10.3 FM Coil Driver Circuit. This circuit controls the current through the YIG's FM coil. This FM current may either increase or decrease the YIG's RF output frequency, as the magnetic field it creates may aid or oppose the magnetic field caused by the current through the Main Tune coil.

4-10.3.1 Input and Error Amplifiers. Differential amplifier A9U1 minimizes the effects of any ground loops. A9U2 compares the voltage across sense resistor A9R7 with the voltage from A9U1. Compensation for the FM coil sensitivity of the individual YIG oscillator is performed by resistors on the A7 PCB.

4-10.3.2 Driver Buffers. The error amplifier's output is applied to a high-current buffer formed by complimentary transistors A9Q3 and A9Q4. The buffer's output is applied to the FM coil through A9R16 and A9R17. With lowlevel ground centered inputs the circuit operates Class A,

but at higher input levels, or when a significant DC offset is present, operation is Class AB or Class B. The maximum current through the FM coil is limited to about 125 mA, which represents a typical frequency change of 40 to 50 MHz.

4-10.3.3 Feedback. The FM coil current is returned to the A9 PCB and flows through precision sense resistor A9R7. Isolation resistor A9R5 couples this voltage back to A9U2, closing the FM control loop.

4-10.4 RF Level Temperature Compensation. A9R25, A9R26, A9R31, and A9CR4 form a bridge which is balanced at +25 degrees C. A9CR4 is at substantially the same temperature as the detector diode in directional detector U2. A9U5 has a gain of 20:1; its output, which is is applied to the A2 PCB, is scaled at -0.875V +0.035 V/°C and is normally 0V at +25°C.

4-10.5 Regulated -5.0V Supply. Certain non-Gunn-diode YIG oscillators require a -5.0V supply for operation. A9U4 produces a regulated -4.75V to -5.25V output at a maximum current of 150 mA. A9R24 limits regulator dissipation. U4's ground terminal is connected to the case of the YIG oscillator for minimum noise.

4-10.6 Vb Driver.

4-10.6.0 Instead of the fixed power supply or supplies required by FET and transistor YIG oscillators, Gunn diode YIG oscillators require a variable DC supply which is inversely proportional to the frequency of oscillation. This variable voltage is called the Vb voltage.

4-10.6.1 Vb Regulator. Regulator A9U6 functions on the same principle as does +17V voltage regulator A9U3, save that A9U6's output voltage is set by circuitry on the A11 Vb and Interface PCB.

4-10.6.2 Regulator Protection and Filtering. A9CR6 and A9CR7 protect A9U6 in the event of short circuits at the regulator's input and output. A9C20 provides a low-impedance source when the instrument is first turned on; this facilitates the initiation of RF oscillation in the Gunn diode.

4-10.6.3 Minimum Load Resistor. Load resistor A9R53 causes A9U6 always to produce an output current of at least 10 mA, the minimum needed for proper regulator operation. The resistor is provided primarily as a troubleshooting aid in the event of a failure in the Gunn diode oscillator; the current required by a Gunn diode oscillator is normally several hundreds of milliamperes and can exceed 1.2 amperes in some circumstances.

4-11 A11 Vb and INTERFACE PCB Assembly, 083456.

4-11.0 The A11 Vb and Interface PCB contains circuitry to adapt the sweeper's inputs and outputs so that they will be compatible with the requirements of network analyzers and other equipment, circuitry to control Vb regulator A9U6 when the 1900B uses a Gunn diode YIG oscillator as its RF source, and an optional squarewave generator for modulation of the RF output.

4-11.1 Penlift and Negative Z Blanking Signals. The RETRACE signal from the A3 PCB is LO during a sweep

and HI for the first 10 mS after a sweep. The signal is applied to inverter A11U3C, whose output drives A11U3D and A11Q1.

4-11.1.1 Penlift. The signal from A11U3D provides an output which may be used to control the penlift function of chart recorders and other similar instrumentation. A LO occurs at rear panel connector J9 during each sweep, a HI appearing between sweeps.

4-11.1.2 Negative Z Blanking. A11Q1 and A11Q2 provide a pulse usable as a blanking input to CRT and similar displays. The output, which appears at rear panel connector J6, is a negative-going pulse whose limits may be +5V and -4.5V, +5V and -13.5V, 0V and -4.5V, or 0V and -13.5V, as desired. A LO at A11U3C's input causes a HI at the inverter's output and forces A11Q1 off. A11Q2 is therefore off and its drain is at +5V if A11SW1 is HI, or 0V if A11SW1 is LO. A HI at A11-U3C's input turns on A11Q1, which in turn causes A11Q2 to turn on. A11Q2's drain drops to -5V if A11SW2 is LO or -15V if A11SW2 is HI.

4-11.2 Marker Pulse. Each time a marker occurs, a LO-going pulse is created by the A3 Ramp and Marker PCB. This pulse is applied to the inputs of A11U3A and A11Q3.

4-11.2.1 Logic Outputs. A11U3A and A11U3B produce complimentary logic pulses. A11SW6 selects the desired polarity.

4-11.2.2 Negative Z Marker. A11Q3 and A11Q4 operate in the same fashion as do A11Q1 and A11Q2. A11Q4's output is a negative-going pulse whose limits may be +5V and -4.5V, +5V and -13.5V, 0V and -4.5V, or 0V and -13.5V, as determined by A11SW3 and A11SW4.

4-11.2.3 Signal Selection. A11SW5 should be HI to select the Negative Z Marker signal from A11Q4, or LO if a logic pulse is desired. The marker output appears at rear panel connector J4.

4-11.3 -5V Regulator. A11U4 provides a regulated -5V supply used by the Negative Z Blanking and Negative Z Marker circuits.

4-11.4 Vb Control Circuitry. Gunn-diode YIG oscillators require a Vb voltage which is inversely proportional to the frequency of oscillation, and, to a lesser extent, inversely proportional to the temperature of the Gunn diode itself. The Vb control circuitry operates in conjunction with the A9 Heatsink assembly to set this Vb voltage.

4-11.4.1 Input Amplifier A11U8A. The Main Tune voltage from the A4 PCB, scaled at +0.59 V/GHz, is sent to A11U8A, whose output is equal to half of the desired Vb voltage. A11R24 and A11R25 calibrate the circuit. A11R22 and A11R25 are selected as appropriate for the YIG oscillator used in the instrument.

4-11.4.2 Vb Temperature Compensation. The optimum Vb voltage for a Gunn diode oscillator at any particular frequency can change as much as several hundred millivolts from 0°C to +50°C. A11CR1 and A11U7 compensate the Vb supply for temperature changes. A11U7's output is scaled at -0.875V +0.035V per degree Centigrade, thus A11U7 has a 0V output at +25°C. A11R19 matches A11U7's output to the individual YIG

oscillator.

4-11.4.3 Vb Error Amplifier A11U8B. The setpoint voltage from A11U8A drives A11U8B's inverting input, while the Vb voltage, returned via a sense line to a 2:1 voltage divider formed by A11R32 and A11R33, drives its non-inverting input. This technique permits A11U8 to use +15V and -15V supplies.

4-11.4.3.1 If the setpoint voltage goes positive, A11U8B's output goes negative; A11Q5 conducts less and the voltage at the adjustment terminal of Vb regulator A9U6 increases. This raises the Vb voltage until there is no voltage difference between A11U8B's two inputs. A11R30 and A11C19, and A11R31 and A11C20, control the error amplifier's bandpass.

4-11.4.4 Vb Linearizer. A11CR2 and A11CR3 linearize A11Q5's current-to-voltage transfer characteristic; the breakpoints are approximately 60 μA and 100 μA respectively. A11CR4 prevents application of large negative voltages to the base of A11Q5.

4-11.4.5 Vb Protection Circuit. Excessive Vb voltage can destroy a Gunn diode. A zener diode is normally installed across the oscillator's Vb terminals, and the circuit described below provides additional protection.

4-11.4.5.1 A9U6 maintains its output terminal 1.25V more positive than its adjustment terminal. As the resistor between these two terminals is 124 ohms, about 10 mA flows through the resistor and into A11 pin (U) on the A11 PCB. When A11Q5 is not conducting, all of this 10 mA must flow through A11R38 and possibly A11R39 and A11R40, depending on whether A11SW9 or A11SW10 is installed. This circuit therefore limits the maximum Vb voltage which may be applied to the oscillator.

4-11.4.6 Reference Voltage. A11U5 and A11U6 provide a -10V reference voltage required for operation of the Vb control circuitry.

4-11.5 Square Wave Generator. Certain network analyzers and other instruments require an RF signal which is pulse-modulated by a square wave. A fixed-rate square wave generator is available for 1900B's which are to be used with such equipment. The nominal square wave frequency is 27.778 kHz.

4-11.5.1 Signal Generation. A11U1 is a multivibrator that oscillates at a frequency determined by A11R7, A11R8, A11C21, A11C22, and the voltage applied to A11U1 pin 5, which is set by A12R4. This permits the multivibrator's frequency to be adjusted from the sweeper's rear panel. A11U2A and A11U2B divide the frequency of A11U1's output by four to produce a square wave at the desired modulation rate. A11U1 oscillates at 111.112 kHz when a 27.778 kHz output is desired.

4-11.5.2 Internal Modulation. The signal from A11U2B is applied to the inputs of A11U3E and A11U3F through A11SW8. A logic HI A11U3F's output turns off the 1900B's RF output. The signal at rear panel connector J10 is in phase with the signal at the output of A11U3F if A11SW7 is LO, and is out of phase if A11SW7 is HI.

4-11.5.3 External Modulation. When an external modulation source is to

be used A11SW8 is not installed and A11SW7 is placed in the HI position. A LO at rear panel J10 turns off the RF output.

4-12 A12 REAR PANEL PCB Assembly, 083761.

4-12.0 The A12 Rear Panel PCB provides several miscellaneous functions necessary for instrument operation.

4-12.1 Adusting the Internal Modulator Frequency. A12R4 adjusts the frequency of the optional modulator on the A11 PCB. The modulator's output frequency may be monitored at rear panel J10.

4-12.2 External Detector Calibration. A12R1 provides an offset adjustment for the directional detector, applying a voltage to the A2 PCB to accomplish this function. A12R2 attenuates the directional detector's output by 0 to 6 dB or more.

4-12.2.1 Normally a directional detector with a coupling factor of 10 to 16 dB should be used; this corresponds to voltages of -10 to -40 mV at 0 dBm. The detector output polarity must be negative. For other coupling factors or polarities, the user must develop some means of compensation so that these requirement can be met. In most cases, the optimum calibration points are +5.0 dBm and -15.0 dBm. Calibrating the external detector over a narrower span within this range is also possible.

4-12.3 IEEE Interface Functions. In the sections below, all comments concerning the IEEE-488 interface assume the presence of the option. Refer to this manual's Operation chapter for further information.

4-12.3.1 IEEE Address Switch A12S1. This switch sets the IEEE address of the instrument, tells the CPU whether to recognize or ignore the Go-To-Local command, and determines whether the sweeper acts as a talk-only device.

4-12.3.1.1 The table below describes the function of each of the eight elements (H to A) of the switch. In all cases, a switch section is in the TRUE position when its slider is moved toward the top of the 1900B. As is conventional for the IEEE interface, a TRUE is the 0V condition while a FALSE is the +5V condition.

Table 3. IEEE Address Switch Elements

Element	Function
H	Not used.
G	Local Lockout
F	Talk Only
E	Address data bit 5 (2^4)
D	Address data bit 4 (2^3)
C	Address data bit 3 (2^2)
B	Address data bit 2 (2^1)
A	Address data bit 1 (2^0)

4-12.3.2 Local Lockout Switch Element. This switch element's setting is read only during the power-on routine, and later changes are ignored.

4-12.3.2.1 Switch Set to "0." Here the sweeper responds to the GTL command by returning instrument control to the front panel. The

sweeper can also be returned to front-panel control by pressing the ENTER key, by disconnecting the interface cable, or by turning the AC power switch OFF.

4-12.3.2.2 Switch Set to "1." Here the GTL command is ignored and control of the sweeper may be performed only via the IEEE-488 interface. The sweeper may be returned to front-panel control only by disconnecting the interface cable or turning the AC power switch OFF.

4-12.3.3 Talk Only. The setting of this switch element is read periodically and the sweeper will respond to a setting change at any time.

4-12.3.3.1 Switch Set to "0." Here the sweeper is in the "program" mode and responds to commands and to requests for information via the interface. The sweeper talks whenever so instructed by the controller, the message sent being either a response to an inquiry or an internally-generated error message. For further information, please refer to the discussion of the IEEE-488 interface in the Operation portion of the manual.

4-12.3.3.2 Switch Set to "1." Here the sweeper is in the "talk-only" mode, ignores external commands from the interface, and will transmit complete information on its internal setup and status whenever the front-panel [ENTER] switch is pressed. With the exception of the additional function for the [ENTER] switch, front-panel operation is not affected.

4-12.3.3.2.1 The receiving device(s) must be equipped either with a "listen-only" function or the user must develop a listen-only interface converter of an appropriate type.

end chapter 4

CHAPTER 5

MAINTENANCE
1900B MICROWAVE SWEEPERS

5-1. INTRODUCTION

5-1.1 This chapter contains procedures to maintain the operating characteristics and specifications of the 1900B Microwave Sweepers.

5-2. SAFETY PRACTICES

5-2.1 Under no circumstances should any person service or adjust equipment unless in the presence of another person who is capable of rendering first aid/resuscitation services in the event of an accident.

5-2.2 Prior to applying power to the 1900 Series instrument, determine that the internal protective power ground is connected to the protective ground conductor of the power cord. This ground, in turn, must be connected through the external power cord to a grounded power outlet. Verify ground continuity from the chassis through the pover cord using an ohmmeter, with power totally removed from the instrument. Whenever it is determined that the protective ground system has been impaired, the equipment must be made inoperative or be secured against inadvertent operation until the deficiency is corrected.

5-2.3 Troubleshooting, repair, or adustments of the 1900B Microwave Sweeper with power applied to the circuits and top cover removed should be performed only by skilled technical personnel who are aware of the various hazards involved.

5-2.4 Under certain conditions, dangerous potentials may still exist when power is removed from the instrument due to charges retained by capacitors. To avoid injury, always remove power then wait for several seconds prior to replacing components or making repairs.

5-2.5 To avoid potential damage to the 1900 Series instrument always turn off power for several seconds before removing or installing any circuit boards and/or discrete components.

5-3. RECOMMENDED TEST EQUIPMENT

5-3.1 Table 3-1 is a list of recommended test equipment. Equipment of equivalent or higher specifications may be substituted. In most cases, a malfunctioning 1900 sweeper may be repaired with the aid of a digital voltmeter, frequency counter, power meter, oscilloscope, suitable coaxial cables, and any required connector adapters.

Table 5-1
Recommended Test Equipment

Type	Model
Digital Voltmeter. Though extreme accuracy is not usually required for trouble shooting, such accuracy is essential if specifications compliance is to be main tained. Pertinent specifications include a resolution of 5-1/2 digits and the ability to resolve voltages as low as 1 microvolt.	SD 7362
Frequency Counter. A microwave counter covering the 1900's frequency span with 10 kHz resolution and with a 50 ohm input is required. Pertinent specifications include the frequency range and a sensitivity of -20 dBm or better.	SD XXXX
Power Meter. A micro wave power meter capable of reading levels from +20 to -20 dBm over the sweeper's frequency range is required. Pertinent specifications include the frequency and level ranges; a power meter with a digital display is suggested	HP 436A Power Meter and HP 8481A (18 GHz) or HP 8485A (26 GHz) Power Heads

Table 5-1
Recommended Test Equipment Cont.

Oscilloscope. Any general purpose dual trace oscilloscope with triggered sweep a vertical sensitivity of 5 mV/division and a bandwidth of at least 100 MHz is suitable.	
Other Useful Equipment	
IEEE-488 Controller/ Computer. When the sweeper has the IEEE -488 interface opt., short computer programs can speed instrument calibration. Any controller or computer which complies with the IEEE-488 (1978) standard is acceptable. A suitable interface cable is also necessary.	
Spectrum Analyzer. A microwave spectrum analyzer is needed to verify AM calibration, FM calibration, and ϕ noise when the sweeper is equipped with the Phaselock option.	HP 8562A, HP 8565A, and HP 8566B
Measurement Receiver In conjunction with a spectrum analyzer, this equipment is essential to trouble shoot phase noise and residual FM problems.	HP 8902

Table 5-1
Recommended Test Equipment Cont.

Torque Wrench. A torque wrench with a 3/8" open-end wrench attachment set for about 8 inch-pounds is desirable for tightening SMA connectors.	3/8" open-end

5-2.0 GENERAL INFORMATION.

5-2.1 Specified Frequency Range. The frequency span over which the instrument specifications apply. The end-points of this range are the lower and upper specified frequencies.

5-2.2 Available Frequency Range. The extreme frequency span covered by the sweeper. The end-points of this range are the minimum and maximum available frequencies. The available frequency range exceeds the specified frequency range, typically by ±100 MHz.

5-2.3 Configuration Switch A1S2.

a. The most significant switch element is toward the top edge of the A1 PC board. Switch elements become less significant moving toward the bottom of the PC board.

b. A switch element is in the "0" position if toward the center of the A1 PCB and in the "1" position if toward the righthand edge of the A1 PCB.

c. The uppermost switch element is not used and should always be set to "0."

d. The second switch element should be set to: "0" when the PHASE LOCK option is NOT present, or "1" when the PHASELOCK option is installed.

e. The third switch element should be set to: "0" when the INTERNAL ALC option is NOT present, or "1" when the INTERNAL ALC option is installed.

f. The lowest five switch elements set the specified frequency range in accordance with the table below.

```
00000:      0 - 20,471 MHz.
                Calibration Mode.
00001:     10 -  2,000 MHz.
00010:  1,000 -  4,000 MHz.
00011:  2,000 -  4,000 MHz.
                Standard 1904B.
00100:  2,000 -  6,000 MHz.
00101:  2,000 -  8,000 MHz.
                Standard 1910B.
00110:  2,000 - 10,000 MHz.
00111:  4,000 -  8,000 MHz.
                Standard 1908B.
01000:  6,000 - 18,600 MHz.
01001:  8,000 - 12,400 MHz.
01010:  8,000 - 18,600 MHz.
01011: 10,000 - 20,000 MHz.
01100: 12,000 - 18,600 MHz.
01101: 18,000 - 26,500 MHz.
                Standard 1926B.
10000:  8,000 - 12,000 MHz.
                Standard 1912B.
10001: 12,000 - 18,000 MHz.
                Standard 1918B.
10010: 18,000 - 26,000 MHz.
```

5-2.4 Lamp Test And Option Acknowledgement Routine. Each time power is first applied or reset switch A1S1 is pressed, the instrument should perform the events below in the stated order.

a. Simultaneously blank all numeric displays, annunciator LEDs, and switch LEDs.

b. Simultaneously light all decimal points, annunciator LEDs, and switch LEDs.

c. Simultaneously light all segments (excluding the decimal points) of each numeric display.

d. Acknowledge presence of the PHASELOCK option, if so instructed by the setting of A1S2.

e. Acknowledge presence of the INTERNAL ALC option, if so instructed by the setting of A1S2.

f. Display the IEEE-488 interface address set by A12S1, if the IEEE-488 option is present.

5-2.5 Digital Voltmeter Zeroing and Setup.

a. Normal DVM Setup.

(1) Set the DVM's internal filter to ON.

(2) Select the 10V range with high resolution.

b. The SD 7362 DVM should be zeroed as follows:

(1) Disconnect the DVM from the instrument.

(2) Short the DVM's inputs together.

(3) Press the ZERO switch.

(4) The DVM may be used as soon as the LED on the ZERO switch goes out.

5-3 CALIBRATION.

5-3.1 Initial Setup.

a. Turn the instrument power switch OFF.

b. Remove the instrument's top and bottom covers and the plastic hold-down block for the A7 and A11 PCB's.

c. Remove the cover securing screws for the A1, A2, A3, and A4 PCB's.

d. YIG Oscillator Protection. Unplug YIG oscillator Y1's power cable from the cable on the A9 Heatsink Assembly. In most cases it will be necessary to cut the two nylon cable ties holding the connector halves together.

CAUTION

Failure to disconnect the YIG oscillator may cause its destruction.

e. Internal Switch Settings.

(1) Temporarily remove the A1 PCB and set A1S2 to 00000000.

(2) Switch Settings: A12S1.

(a) Verify that Local Lockout is set to "0."

(b) Verify that Talk Only is set to "0.".

(c) Verify that the IEEE address is set to 25 (11001).

NOTE: On A12S1, a switch element is in the "0" position when moved toward the instrument's bottom and in the "1" position when moved toward the instrument's top.

f. Turn the instrument power switch ON and verify correct operation of cooling fan BL1.

WARNING

Personal injury may occur if fingers or other items are inserted into the cooling fan.

5-3.2 Power Supply Voltages.

a. A8 Power Supply PCB. Verify that the power supply voltages on the A8 PCB are within the limits specified below.

(1) Unregulated +12V:
+9.00V to +14.00V.

(2) Unregulated -18V:
-18.00V to -26.00V.

(3) Unregulated +28V:
+22.00V to +31.00V.

(4) Unregulated +36V:
+26.80V to +38.50V.

(5) Regulated +5V Logic:
+4.75V to +5.25V.

(6) Regulated +5V Display:
+4.75V to +5.25V.

(7) Regulated +15V:
+14.25V to +15.75V.

(8) Regulated -15V:
-14.25V to -15.75V.

(9) Regulated +24V:
+22.80V to +25.80V.

b. A9 Heatsink PCB.

(1) Regulated +17V Main Tune Supply.
Verify that A9U3's output is within the limits below, selecting A9R18 if necessary.

Units to 12 GHz:
+16.20V to +17.50V.

Units above 12 GHz:
+17.00V to +18.50V.

(2) Regulated -5V YIG Bias Supply.
If A9U4 is installed, verify that the voltage between A9E2 (ground) and A9E1 (input) is -4.75V to -5.25V.

5-3.3 Stabilization. Permit the instrument to operate at the local ambient temperature for 60 minutes minimum before proceeding with the remainder of this procedure.

5-3.4 Sweep Time Calibration.

a. Test Setup.

(1) Turn the instrument power switch OFF.

(2) Remove the A3 PCB and reinstall with an extender board.

(3) Verify that jumper A3W1 is installed and that jumpers A3W2 and A3W3 are NOT installed.

(4) Turn the instrument power switch ON.

(5) Verify that markers M1 through M5 are cleared.

b. Ramp DAC Calibration Check.

(1) Zero the DVM as described in paragraph 5-2.5.

(2) Connect the DVM return to A3TP1 and its input to A3TP2.

(3) Set START/STOP sweep mode with AUTO trigger.

(4) Set a sweep time of 00.010 seconds. Verify -9.975V to -10.025V at the test point.

(5) Set a sweep time of 01.000 seconds. Verify -0.085V to -0.115V.

c. Integrator Drift Calibration.

(1) Zero the DVM as in paragraph 5-2.5 except that the 1V range should be used.

(2) Connect the DVM return to A3TP1 and its input to A3U6 pin 2.

(3) Select CW mode.

(4) Adjust A3R8 for as close as possible to ±0.000,000V at the test point.

(5) Observe the DVM for a period of 60 seconds. Verify that the voltage remains within -0.000,009V to +0.000,009V for the entire observation period.

(6) Remove the DVM input from A3U6 pin 2.

d. Counter-Timer Test Setup.

(1) Connect the TIM gating input to A3U11 pin 8.

(2) Set the timer to begin measurements upon the LO-to-HI edge of a logic pulse.

(3) Set the timer to end each measurement upon the HI-to-LO edge of a logic pulse.

e. Sweep Time Calibration.

(1) Set a sweep time of 01.000 seconds.

(2) Adjust A3R6 for 0.998 to 1.002 seconds.

(3) Set a sweep time of 10.000 seconds.

(4) Verify a time interval of 9.750 to 10.250 seconds.

(5) Set a sweep time of 20.000 seconds.

(6) Adjust A3R8 if necessary for a time interval of 19.500 to 20.500 seconds.

5-3.5 Output Frequency Calibration. When the instrument uses a YIG oscillator with a very large offset in its current-to-frequency curve, the accuracy of the instrument's frequency calibration can often be improved somewhat by repeating this entire paragraph several times.

a. Test Setup.

(1) Turn the instrument power switch OFF.

(2) Reinstall the A2 PCB without an extender board. Next, remov

the A4 PCB and reinstall with an extender board.

(3) Remove jumper A4W1 and install jumper A4W2.

(4) Turn the instrument power switch ON.

(5) Zero the DVM as described in paragraph 5-2.5, then Connect the DVM return to A4TP1 and its input to A4TP4.

(6) Set a START frequency of 00000 MHz.

(7) Set a CW frequency of 00000 MHz.

Note the EXACT voltage at A4TP4 and record its value with 10-μV resolution as Zero-Set Voltage V0.

b. DAC Calibration.

(1) Set a CW frequency of 04095 MHz.

(a) Adjust A4R5 for V0 +2.416,05V.

(b) Verify V0 is +2.415,75V to V0 +2.416,35V.

(2) Set a STOP frequency of 04095 MHz.

(a) Adjust A4R15 for V0 +2.416,05V.

(b) Verify V0 is +2.415,75V to V0 +2.416,35V.

(3) Set a CW frequency of 16384 MHz.

(a) Adjust A4R1 for V0 +9.666,56V.

(b) Verify V0 is +9.666,26V to V0 +9.666,86V.

(4) Set a STOP frequency of 16384 MHz.

(a) Adjust A4R10 for V0 +9.666,56V.

(b) Verify V0 is +9.666,26V to V0 +9.666,86V.

(5) Repeat paragraphs 5-3.5b(1) through 5-3.5b(4) until no further adjustment is required.

c. V(F) Calibration.

(1) Zero the DVM as described in paragraph 5-2.5.

(2) Connect the DVM to the V(f) Output J1.

(3) Set a CW frequency of 0 MHz Adjust A2R41 for -0.000,50V to +0.000,50V.

(4) Set a CW frequency of 18000 MHz. Adjust A2R45 for +17.999,50V to +18.000,50V.

(5) Repeat paragraphs 5-3.5c(3) and 5-3.5c(4) until no further adjustment is required.

d. Vb Calibration.
Perform the procedures below ONLY if the sweeper uses a Gunn-diode YIG oscillator. Refer to the ITP Data Sheet for the Vb parameters F1, F2, V1, and V2.

(1) Connect the DVM's return to A11TP1 and its input to A11TP4.

(2) Set the CW frequency to F1. Adjust A11R21 for a voltage within ±0.075V of V1.

(3) Set the CW frequency to F2. Adjust A11R24 for a voltage within ±0.075V of V2.

(4) Repeat paragraphs 5-3.5d(2) and 5-3.5d(3) until no further adjustment is required.

e. Test Setup Change.

(1) Turn the instrument power switch OFF.

(2) Referring to paragraph 5-2.3, set A1S2 as appropriate for the instrument's option configuration and frequency range.

(3) Remove jumper A4W2 and install jumper A4W1. Next, reinstall the A4 PCB without an extender board.

(4) Reconnect Y1's power cable to the A9 Heatsink Assembly cable.

(5) Connect a counter set for 10 kHz resolution to the RF output.

(6) Turn the instrument power switch ON and allow the sweeper to operate undisturbed for 10 minutes.

f. Output Calibration.

(1) Set the upper specified CW frequency. Adjust A4R23 for an output within 0.1 MHz of the setpoint value.

(2) Set the lower specified CW frequency. Adjust A4R28 for an output within 0.1 MHz of the setpoint value.

(3) Repeat paragraphs 5-3.5f(1) and 5-3.5f(2) until no further adjustment is required.

(4) Set the lower specified CW frequency. Adjust A4R23 for an output within 0.1 MHz of the setpoint value as modified by the calibration offset from the ITP Data Sheet.

5-3.6 RF Level Calibration.

a. Test Setup.

(1) Turn the instrument power switch OFF.

(2) Remove the A2 PCB and reinstall with an extender board.

(3) Connect the DVM return to A2TP1 and its input to A2TP7.

(4) Turn the instrument power switch ON.

(5) Set a CW frequency near the middle of the specified frequency range.

b. Manual Level Adjust Functional Check.
Perform the procedures below only if the instrument is NOT equipped with the INTERNAL ALC option.

(1) Connect the RF power meter to the RF output.

(2) Using the spinwheel, decrement the RF level until a [-Er] level display flash is obtained.

(3) Using the spinwheel, slowly increment the RF level while monitoring the actual RF output.

(4) Verify that the RF output increases monotonically with rotation of the spinwheel.

(5) Verify that actual RF outputs from -8.0 dBm or less, to +5.0 dBm or more, are available.

c. External ALC Calibration.

(1) Connect the input of a 16-dB directional detector to the RF output.

(2) Connect an RF power meter to the output of the directional detector.

(3) Connect the detector output of the directional detector to the EXT ALC input.

(4) Set EXT ALC to ON.

(5) Set an RF level of -15.0 dBm (remote program) or adjust the level for +2.070V (nominal) at A2TP7.

(6) Adjust A12R1 for an actual RF output of -14.95 to -15.05 dBm.

(7) Set an RF level of +5.0 dBm (remote program) or adjust the level for +5.977V (nominal) at A2-TP7.

(8) Adjust A12R2 for an actual RF output of +4.95 to +5.05 dBm.

(9) Repeat paragraphs 5-3.6c(5) through 5-3.6c(8) until no further adjustment is required.

(10) Set EXT ALC to OFF.

d. A-to-D Converter Calibration.

(1) Set an RF level of +5.0 dBm (remote program) or adjust the level for +5.977V (nominal) at A2TP7.

(2) Adjust A2R53 for a level display of +5.0 dBm.

(3) Set an RF level of -15.0 dBm (remote program) or adjust the level for +2.070V (nominal) at A2TP7.

(4) Adjust A2R56 for a level display of -15.0 dBm.

(5) Repeat paragraphs 5-3.6d(1) through 5-3.6d(4) until no further adjustment is required.

e. Internal ALC Calibration. Perform the steps below ONLY if the instrument is equipped with the INTERNAL ALC option.

(1) Test Setup.

(a) Remove the directional detector installed in paragraph 5-3.6b.

(b) Connect the RF power meter to the RF output.

(c) Connect the detector out put of directional detector U2 to A2J2.

(2) Set an RF level of -15.0 dBm (remote program) or adjust the level for +2.070V (nominal) at A2TP7.

(3) Adjust A2R20 for an actual RF output of -14.98 to -15.02 dBm.

(4) Set an RF level of +5.0 dBm (remote program) or adjust the level for +5.977V (nominal) at A2TP7.

(5) Adjust A2R29 for an actual RF output of +4.98 to +5.02 dBm.

(6) Repeat paragraphs 5-3.6e(2) through 3.6e(5) until no further adjustment is required.

5-3.7 Marker Calibration.

a. Test Setup.

(1) Turn the instrument power switch OFF.

(2) YIG Oscillator Protection. Unplug YIG oscillator Y1's power cable from the A9 Heatsink Assembly cable.

CAUTION

Failure to disconnect the YIG oscillator may cause its destruction.

(3) Set A1S2 to 000-00000.

(4) Remove the A3 PCB and reinstall with an extender board.

(5) Turn the instrument power switch ON.

(6) Zero the DVM as in paragraph 5-2.5 except that the 1V range should be used. Next, connect the DVM return to A3-TP4 and its input to A3TP8.

b. Marker Calibration.
This procedure calibrates the markers with respect to the Main Tune Voltage from the A4 PCB.

(1) Set CENTER/DELTA sweep mode with a DELTA of 00000 MHz.

(2) Set a CENTER frequency of 00000 MHz.

(a) Clear all markers.

(b) Adjust A3R25 for -0.000,60V to +0.000,60V.

(3) Set a CENTER frequency of 04095 MHz.

(a) Select M2. Verify a display of 04095 MHz.

(b) Adjust A3R29 for -0.000,60V to +0.000,60V.

(4) Set a CENTER frequency of 16384 MHz.

(a) Select M5. Verify a display of 16384 MHz.

(b) Adjust A3R22 for -0.000,60V to +0.000,60V.

(5) Repeat paragraphs 5-3.7b(2) through 5-3.7b(4) until no further adjustment is required.

5-3.8 Final Setting of A1S2.

a. Turn the instrument power switch OFF.

b. Reinstall the A3 PCB without an extender board.

c. Referring to paragraph 5-2.3, set A1S2 as appropriate for the

sweeper's option configuration and frequency range.

d. Re-connect Y1's power cable to the A9 Heatsink Assembly cable.

e. Turn the instrument power switch ON.

5-3.9 Phaselock Verification. Perform the procedures below ONLY if the sweeper is equipped with the PHASELOCK option. If desired, the sweeper's RF output may also be monitered by a spectrum analyzer; this requires either repeated connection changes or the use of a suitable power splitter or directional coupler.

a. Connect a counter set for 10 kHz resolution to the sweeper's RF output.

b. Select PHASELOCK mode and set the highest specified frequency.

c. Phaselock Verification.

(1) Decrement the PHASELOCK frequency from the maximum available frequency to the minimum available frequency. For each step, verify phase lock at the correct frequency.

(2) Increment the PHASELOCK frequency from the minimum available frequency to the maximum available frequency. For each step, verify phase lock at the correct frequency.

5-3.10 Final Steps.

a. Turn the instrument power switch OFF.

b. Install the cover securing screws for the A1, A2, A3, and A4 PCBs. Be careful not to crossthread the screws, as this may create small metal particles or conductive dust which must be removed before the sweeper can be used again.

c. Reinstall the plastic hold-down block for the A7 and A11 PCB's and the top and bottom covers.

d. Perform an Acceptance Test to verify correct function of the sweeper.

5-4 TROUBLESHOOTING NOTES.

5-4.1 Purpose. This section describes a number of instrument failure modes and suggests possible areas where contributing faults may lie. It is not intended to be a all inclusive comprehensive troubleshooting guide, nor does it specifically list all possible defects. As with virtually any other device or instrument, effective and efficient troubleshooting in the 1900 series sweepers has three essential requirements:

a. An accurate description of the task or tasks the instrument fails to perform;

b. Knowledge of the manner in which the instrument operates; and

c. The ability to apply this knowledge so that the logical cause of the instrument fault can be determined.

5-4.2 Special Repair Procedures. Refer to paragraph 5-5 for a number of special procedures which may facilitate or simplify instrument repair.

WARNING

For safety, disconnect all AC power from the sweeper before investigating AC power defects or changing a fuse. Contact with the AC line voltage can be fatal.

5-4.3 Instrument Does Nothing. The instrument is dead; there is no RF output and the front panel is dark and inoperative.

a. No AC power applied.

(1) Ascertain whether or not the cooling fan works.

(2) Verify that the AC power cord is properly connected to an appropriate AC power source.

(3) Verify that the sweeper's power switch is ON.

b. Blown fuse(s).
The fuse ratings specified for the 1900 are proper for all normal and most abnormal circumstances other than catastrophic instrument failure. A fuse should only fail due to a fault in the sweeper, or due to a random fault within the fuse itself.

c. Internal AC wiring defect.
One of the connectors which mate the AC power wiring to the front panel power switch may have come loose, or the wiring may have failed due to a bad solder joint, broken wire, etc. Note that if an AC wire shorts to the chassis one or both line fuses will blow.

d. Short Circuit On Transformer Secondary. Most failures of this type will cause one or both fuses to blow. Note that the transformer secondaries have low DC resistance. Also, the cases of the regulators on the A8 PCB are isolated from the heatsink; those whose cases are at ground potential are connected to ground through the A8 PCB and the wiring.

(1) A transformer secondary may have shorted to ground or to some other point, either directly or through the wiring.

(2) A rectifier diode may have shorted, or its output may have developed a short to ground or to some other point.

(3) A filter capacitor on the A8 PCB may have developed a short.

(4) Conductive material may have entered the region between the A8 PCB and its heatsink, causing a short.

(5) Burred material on the upper surface of the A8 PCB's heatsink can penetrate the insulating washer used under the -15V regulator A8U4, causing a short.

e. Defect On A1 PCB.
On rare occasions, a fault in the microprocessor system can disable the entire instrument.

5-4.4 Instrument Works But Displays Are Strange or Dead. The instrument performs at least some of its functions but the front panel does not work properly: or, one or more numeric displays or LEDs do not light, the numeric displays produce strange

characters, or blink slowly, or otherwise indicate incorrect operation.

NOTE: The CPU must be reset after the fault has been located and repaired. Cycle the AC power off, then on, to reset the CPU.

a. Loose Ribbon Cable.
The ribbon cable between the A1 and A5 PCBs is loose. Press the connector(s) tightly down, then snap the cable latches into place.

b. Ribbon Cable Installed Backwards.
The ribbon cable between the A1 and A5 PCBs is installed backwards. Install the connector correctly, then snap the cable latches into place. An error of this sort should not damage any components.

c. Missing Power Supply.
The A5 PCB is missing its +5V power supply or the ground return for this supply.

CAUTION

Incorrect installation of the +5V Display may destroy components on the A5 PCB.

d. Broken Ribbon Cable or Mating Connector.

(1) Defective cables must be replaced.

(2) Misaligned pins in a mating connector can often be bent back into place, but sometimes the pin will break when this is attempted.

(3) For large misalignments or broken pins, the defective part must be replaced.

e. A5 PCB Faulty or Incorrectly Installed.

(1) Verify correct installation of A5U1 and A5U14.

(2) Verify the correct signals at the outputs of A5U4, A5U5, and A5U6.

(3) The A5 and A6 PCBs must be correctly mated in order to work correctly. Misalignment of the connectors may cause component damage.

f. One or More Displays or LEDs Always On.
This is usually due to a faulty digit driver or segment driver (A5U7, A5U8, A5U9, A5U10, A5U2, A5Q1). Note that shorting the base of one of the digit driver transistors to ground destroys the transistor.

g. One or More Displays or LEDs Never Lights.
This may be caused by a defective digit or segment driver as above, or by a burned-out display or LED.

5-4.5 Shaft Encoder and/or Keyboard Does Not Work. The instrument ignores rotation of the shaft encoder and/or pressing of the keyswitches.

a. Loose Shaft Encoder Ribbon Cable.
The ribbon cable between the shaft encoder and the A5 PCB is loose. Press the connector

tightly down, then snap the cable latches into place.

b. Faulty Shaft Encoder Ribbon Cable or Mating Connector.

(1) If the cable is defective the entire shaft encoder must be replaced.

(2) Misaligned pins in a connector can often be bent back into place, but sometimes the pin will break when this is attempted.

(3) For large misalignments or broken pins, the defective part must be replaced.

c. Faulty Keyswitch.
Since the keyswitches are mechanical devices, they are subject to wear. Also, foreign substances may result in an insulating material between the switch contacts.

d. Fault on A5 PCB.

(1) Verify that A5U14 is correctly installed.

(2) Verify presence of the CHECK and ~IRQ signals on A5U14.

(3) Rotate the shaft encoder and verify that signals appear on the outputs of A5U11A and A5U11B, and that the count in A5U12 and A5U13 changes.

5-4.6 RF Output Level Does Not Match Display.

a. RF Muted.
Verify operation of the front-panel RF ON/OFF switch.

b. Loose Cable(s).
Verify correct installation of the following cables:

(1) Cable from A2J1 to leveling module U1.

(2) If Internal ALC option is installed, the cable from A2J1 to directional detector U2.

(3) Cable from A2J3 to A12 PCB (via wiring harness).

c. Incorrect Calibration of A2 PCB.
Recalibrate the A2 PCB.

d. Dirty or Contaminated A2 PCB.
Clean the A2 PCB. Be sure to check for contamination under the three SMB connectors, and for general PCB cleanliness.

e. Fault on A2 PCB.

f. Fault on A9 PCB.
The temperature compensation voltage is incorrect.

g. Inoperative YIG Oscillator.

(1) Verify that Y1's power connector is correctly plugged in.

(2) Verify that the A9 Heatsink Assembly's power connector is correctly plugged in.

h. Defective Microwave Component or Coaxial Cable.
The operation of leveling module U1 can be verified in part by measuring the signal at U1's coupler port; the signal should be -18 to -22 dBc with respect to the level of the signal at the module's input.

i. Fault on A1 PCB.

(1) The portion of A1S2 relating to the Internal ALC option is set incorrectly. Verify the setting.

(2) The CPU sends no or incorrect information to the A2 PCB. Verify that the software checksum is correct (see paragraph 5-5.1).

5-4.7 Output Frequency Is Incorrect.

a. Incorrect Calibration of A4 PCB.

b. Dirty or Contaminated A4 PCB.

c. Incorrect Jumper. A4W1 should be installed.

d. Fault on A4 PCB.

e. Fault on A9 PCB: Main Tune Driver. The YIG oscillator may be inoperative due to insufficient or absent main tuning current.

f. Vb Voltage Faults on A9 and A11 PCBs. These apply only when Y1 is a Gunn-diode oscillator. The Vb voltage is incorrect due to a fault involving:

(1) A9U4, A11U4, A11U5, A11U7, A11U8, or A11Q5.

(2) the installation of A11SW9 or A11SW10.

g. Inoperative YIG Oscillator.

(1) Verify that oscillator Y1's power connector is correctly plugged in.

(2) Verify that the A9 Heatsink Assembly's power connector is correctly plugged in.

h. Defective Microwave Components. A fault in the leveling module, harmonic filter, directional detector, or the various coax cables may prevent the appearance of a signal at the RF output connector.

i. FM-related Faults. This is likely to affect the RF level only when a spectrum analyzer or similar instrument is being used to measure the power output level.

(1) An external FM signal, possibly with a significant DC offset, is applied.

(2) Fault involving A9U1, A9U2, A9Q1, or A9Q2.

(3) If the Phaselock option is installed, a fault involving A7K1 or A7K2.

j. Faults on A1 PCB.

(a) The band select part of A1S2 is set incorrectly. Verify the setting.

(b) The CPU sends no or incorrect information to the A4 PCB. Verify that the software checksum is correct (see paragraph 5-5.1).

5-4.8 Instrument Won't Sweep.

a. Incorrect Jumpers.

(1) Internal sweep: install A3W1 and A4W4.

(2) External sweep: install A3W2 A3W3 and A4W4.

b. Sweep Halt Signal Applied.

c. Fault on A3 PCB.

d. Fault on A4 PCB.

e. Fault on A1 PCB.
The CPU sends no or incorrect information to the A3 or A4 PCB. Verify that the software checksum is correct (see paragraph 5-5.1).

5-4.9 Incorrect Marker Functions.

a. Instrument is being operated in external sweep mode.

b. Incorrect Calibration of A3 PCB.

c. Dirty or Contaminated A3 PCB.

d. Fault on A3 PCB.

e. Fault on A4 PCB: Main Tune Voltage.

f. Fault on A11 PCB.

5-4.10 Incorrect Instrument Response To IEEE-488 Interface.

a. The external IEEE interface cable is incorrectly installed.

b. IEEE Switch A12S1 Not Set Correctly.

(1) Verify the setting of IEEE address during the Lamp Test and Option Acknowledgement Routine. Changes in the IEEE address after the initial application of power are not recognized.

(2) The Talk-Only Switch is set to Talk.

c. Internal Ribbon Cables.

(1) Verify the condition and correct installation of the IEEE signal cable from A1J2 to A12. Verify that A1J2's ears are latched into place.

(2) Verify the condition and correct installation of the IEEE address cable from A1J3 to A12.

d. Fault on A1 PCB.
Verify that the software checksum is correct (see paragraph 5-5.1).

e. The IEEE-488 Option is not present.

5-5 SPECIAL TEST AND REPAIR PROCEDURES.

5-5.1 Special Software and Keyboard Check Routine.

a. Turn the instrument power switch OFF and unplug YIG oscillator Y1's power cable from the wire harness.

CAUTION

Failure to disconnect Y1's power cable may result in damage to, or destruction of, the YIG oscillator. Y1 is the most expensive component of the sweeper and the cost of a replacement may be several thousand dollars.

b. Remove the A1 PCB from the instrument, set the lowest five sections of A1S2 to 11111, then

reinstall the A1 PCB. Figure 5.1 shows the proper setting of this switch for this purpose.

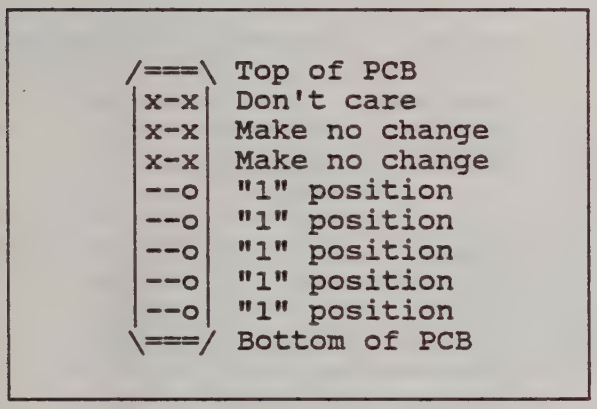


Figure 5-1 Correct Setting of A1S2

c. Turn the instrument power switch ON.

d. Lamp Test and Option Acknowledgement.
The instrument should perform a normal Lamp Test and Option Acknowledgement routine (see the Calibaration section).

e. Slow Lamp Test Routine.
After the lamp test, all segments including the decimal point of each numeric display should illuminate, one display at a time, shifting rightward from the leftmost at roughly one display per second.

f. Software Checksum Verification Routine.
After the Slow Lamp Test, the numeric displays should blank and the annunciator and switch LEDs light. Next, the left display should indicate the revision level of the instrument software and the center display a software checksum. The revision level and checksum for your instrument are found on the ITP Data Sheet.

g. Keyboard Functional Verification Routine.
The Software Checksum Routine should end after about six seconds. Next, the left display should change to read [Pb=] and the center display should blank. If a keyswitch is now pressed, the center display indicates the name of the switch. CPU recognition of each front panel keyswitch can be manually verified.

h. Turn the instrument power switch OFF.

i. Referring to paragraph 5-2.3, return A1S2 to the correct setting for the instrument's option configuration and frequency range.

j. Reconnect Y1's power cable to the A9 Heatsink Assembly cable.

5-5.2 Repairs To Front Panel PCBs.

a. Remove all AC power from the instrument.

b. Remove top and bottom covers.

c. Remove front panel assembly.

(1) Remove the four vertical end trim pieces at the rear of the sweeper.

(2) Slide the two decorative side panels from the instrument.

(3) Disconnect the ribbon cable from the A5 PCB.

(4) Disconnect the semirigid coaxial cable from the front panel's RF output connector.

(5) Remove the front panel assembly from the sweeper.

d. Remove the A5 and A6 PCBs.

(1) Remove the keycaps from the switches, being careful not to damage the soft plastic of the keycaps.

(2) Remove the screws which hold the PCBs to the front panel, then slide the PCBs away to the rear.

e. Reassembly is the reverse of the disassembly procedure.

5-5.3 Replacing Defective Numeric Displays and Annunciators.

a. Unplug the defective component and install a new one.

b. Reconnect the ribbon cable to the A5 PCB.

c. Carefully apply AC power to the instrument and turn the AC power switch ON. Verify that the new part operates properly, then remove the AC power source

d. Reassemble the instrument.

5-5.4 Replacing Defective Keyswitches and Keyswitch LEDs.

a. Remove the instrument front panel.

b. Separate the A5 and A6 PCBs. Unscrew the hardware which holds the A5 and A6 PCB,s together. Hold the A6 PCB in one hand and slowly pry the A5 PCB from the A6 PCB, being careful not to damage the connectors which mate the two PCBs.

c. Unsolder the keyswitch and solder a replacement in place. If necessary, transfer the clear plastic light pipe from the old switch to the new one.

d. Remove all solder flux and other contaminants from the PCB, then reconnect the two PCBs.

e. Reconnect the ribbon cable to the A5 PCB.

f. Carefully apply AC power to the instrument and turn the AC power switch ON. Verify that the new part operates properly, then remove the AC power source

g. Reassemble the instrument.

NOTE: When a keyswitch LED fails, it is strongly recommended that the entire switch be replaced, as the lifespan of the LED is usually much longer than that of the switch. However, if it is necessary to replace only the LED, first note the polarity marks on the LED holder on the bottom of the faulty switch assembly. Next, insert a screwdriver into the slot in the LED holder assembly on the bottom of the switch, turn the screwdriver counter-clockwise a quarter of a turn, and pull the LED holder away from the switch. Next, install a new LED holder by reversing this procedure, being absolutely certain to install the new part with the correct polarity. Finally, install the keyswitch assembly into the PCB as above.

5-5.5 Initial Instrument Cleaning After Water Contamination. If the instrument has been submerged, or if its interior has been exposed to salt water, heavy rain, or heavy water spray, the procedures below should be performed to protect the sweeper from further damage.

a. Remove any source of AC power from the instrument.

b. Disassemble the instrument, removing its plug-in PCBs, fuses, the microwave component mounting bracket, assemblies, and the heatsink-mounted devices on the A8 and A9 assemblies.

c. Gently wash the instrument and each removed assembly in a mild detergent solution to remove any mud, dirt, or corrosion.

d. Thoroughly rinse the instrument and each removed assembly in clean water.

e. Allow the instrument and all removed components to dry THOROUGHLY, preferably in a low-humidity environment at a temperature of +35°C to +50°C. This should usually take 12 to 24 hours.

f. If returning the sweeper to the factory for overhaul and renovation, be certain to describe in as much detail as possible the type of water damage or contamination which has occurred. It is not necessary to reassemble the instrument, but this may be desirable to ensure that all of its components are present.

5-5.6 Non-Factory Instrument Cleaning After Water Contamination. If the instrument can not be returned to the factory for overhaul and repair after water contamination, the steps below may prove useful in returning the 1900 sweeper to service. If desired, you may request a complete set of board-level initial turn-on and calibration procedures from the factory.

a. Remove any source of AC power from the instrument.

b. Disassemble the instrument, removing its plug-in PCBs, fuses, the microwave component assemblies, and the heatsink-mounted devices on the A8 and A9 assemblies.

c. Thoroughly rinse each plug-in PCB in de-ionized water (or distilled water, if de-ionized water is not available), repeating as necessary until the rinse water indicates no significant increase in conductivity due to the rinse procedure.

d. Remove the covers from microwave leveling module U1 and thoroughly rinse the interior of this assembly in de-ionized water (or distilled water, if de-ionized water is not available), repeating as necessary until the rinse water indicates no significant increase in conductivity due to the rinse procedure. Do not touch any of the components within the module.

CAUTION

Use of force in cleaning may demage or destroy the module.

e. If the Phaselock option is installed, remove sampler driver assembly A7A1 from the A7 PCB and remove the cover from the sampler driver assembly. Thoroughly rinse the interior of this assembly in de-ionized water (or distilled water, if de-ionized water is not available), repeating as necessary until the rinse water indicates no significant increase in conductivity due to the rinse procedure. Do not touch any of the components within the sampler portion of this assembly.

CAUTION

Use of force in cleaning may damage or destroy the sampler.

f. Dry the various PCBs and assemblies at a temperature of about +40°C for at least 24 hours (preferably 48 hours).

g. Reassemble the instrument.

h. Turn the sweeper on. Allow it to operate for at least 96 hours (4 days) before recalibration.

5-5.7 Replacement Of Module U1 or Directional Coupler U2.

a. Turn the instrument power switch OFF and remove the AC power source. Remove the instrument's top cover.

b. Loosen the Y1 end of the semi-rigid coaxial cable between Y1 (or U3) and U1. Disconnect the cable from module U1 and swing it out of the way. For model 1910's, follow a similar process with the semi-rigid cables between Y1 and the output of module U1.

c. For instruments with the Phaselock option. Loosen the A7 end of the semi-rigid coaxial cable connected to U1. Disconnect the cable from the module and swing it out of the way.

d. Loosen (but do not remove) the mounting screws holding the microwave component bracket to the A9 Heatsink Assembly.

e. Loosen the front panel end of the semi-rigid coaxial cable attached to the output connector. Disconnect the cable from the output of U2 (U1 for instruments without Internal ALC, or Y1 for model 1910's), and move it clear.

f. Completely unscrew (but do not remove) the mounting screws which hold the microwave bracket to the A9 Heatsink Assembly. Remove the bracket by pulling it up and slightly toward the center of the instrument, being careful not to drop the mounting hardware into the sweeper.

g. Loosen the screws which mount the component to be removed. When appropriate, unscrew the harmonic filter adapter that mates U1 and U2. Finally, remove the mounting screws, then the desired component.

h. Reassembly is the reverse of the above. The SMA coaxial connectors should be torqued to 8.0 to 9.0 inch-pounds (slightly more than finger-tight).

5-5.8 Replacement Of YIG Oscillator Y1.

a. Turn the instrument power switch OFF and remove the AC power source. Remove the instrument's top cover.

b. For instruments with the Phase-lock option. Loosen the A7 end of the semi-rigid coaxial cable connected to U1. Disconnect the cable from the module and swing it out of the way.

c. Loosen the front panel end of the semi-rigid coaxial cable attached to the output connector. Disconnect the cable from the output of U2 (or U1 for instruments without Internal ALC), and move it clear.

d. Loosen the Y1 end of the semi-rigid coaxial cable between Y1 (or U3) and U1. Disconnect the cable from Y1 (or U3) and swing it out of the way.

e. Unplug the connector between the A9 Heatsink Assembly and the instrument's main cable harness. Next, disconnect the cable between Y1 and the A9 Heatsink Assembly cable.

CAUTION

Be careful not to damage the exposed, fragile pins of the cable connectors.

f. Remove the four screws holding the A9 Heatsink Assembly to the chassis, being careful not to drop any mounting hardware into the sweeper. These screws are located at the front end of the heatsink and just in front of Y1. In some units, these rear screws also help secure an adapter plate which mounts the YIG oscillator to the heatsink.

g. Remove the A9 Heatsink Assembly by lifting it upward and slightly toward the center of the instrument.

h. Removing YIG Oscillator Y1.

(a) If Y1 is mounted to the A9 Heatsink Assembly either directly or by a vertical adapter plate, unscrew the oscillator's mounting screws. The oscillator may now be lifted free of the A9 Heatsink Assembly.

(b) If Y1 is mounted to the A9 Heatsink Assembly by a horizontal adapter plate, unscrew the mounting screws under the adapter, then lift the oscillator and adapter from the A9 Heatsink Assembly. The oscillator may now be separated from the adapter plate.

i. Reassembly is the reverse of the above. Use a small amount of thermally-conductive grease between all mounting surfaces. The SMA coaxial connectors should be torqued to 8.0 to 9.0 inch-pounds (slightly more than finger-tight).

NOTE: When a replacement oscillator is installed, a complete recalibration of frequency and marker parameters is essential. Also, it is likely that it will be necessary to select new values for: A4R24; A4R54 or A4R55; A7R29; A7R31; A11R22; and A11R25.

1900 SERIES
SWEEP GENERATORS

SYSTRON DONNER

SPECIFICATIONS

FREQUENCY

Resolution

Phaselock frequencies: 100 MHz
CW, Sweep, Markers: 1 MHz

Model	Range (GHz)	Accuracy (15°C–35°C)	
		CW Mode (MHz)	Swept Mode (MHz)
1904	2.0–4.0	±10	±35
1908	4.0–8.0	±15	±45
1910	2.0–8.0	±25	±60
1912	8.0–12.0	±30	±60
1918	12.0–18.0	±40	±80
1926*	18.0–26.5	±75	±125

*Available Fall 1988

All units have over-range of typically ±100 MHz. Sweep accuracy applies to internal sweep times of 100 ms or more.

Frequency Stability, Unlocked

Model	vs. Temp (MHz/°C)	vs. Time (MHz)	vs. Line (MHz)
1904	±0.4	±0.2	±0.4
1908	±0.8	±0.2	±0.8
1910	±1.0	±0.2	±1.5
1912	±1.2	±0.5	±1.2
1918	±1.8	±1.0	±1.8
1926	±2.6	±2.5	±2.6

Stability vs. temperature is limited by the frequency accuracy specified above.

Stability vs. time is measured over a 10-minute period 60 minutes after tuning to a new frequency. For very long periods at the same frequency, frequency stability vs. time is essentially equal to the residual FM of the instrument.

OUTPUT CHARACTERISTICS

SPECTRAL PURITY

Model	Harmonic (dBc)	Residual FM (kHz)
1904	−40	18
1908	−40	18
1910	−40	15
1912	−50	25
1918	−50	40
1926	−50	60

Harmonics are measured at +5.0 dBm. Residual FM is measured in a 20 Hz to 20 kHz bandwidth.

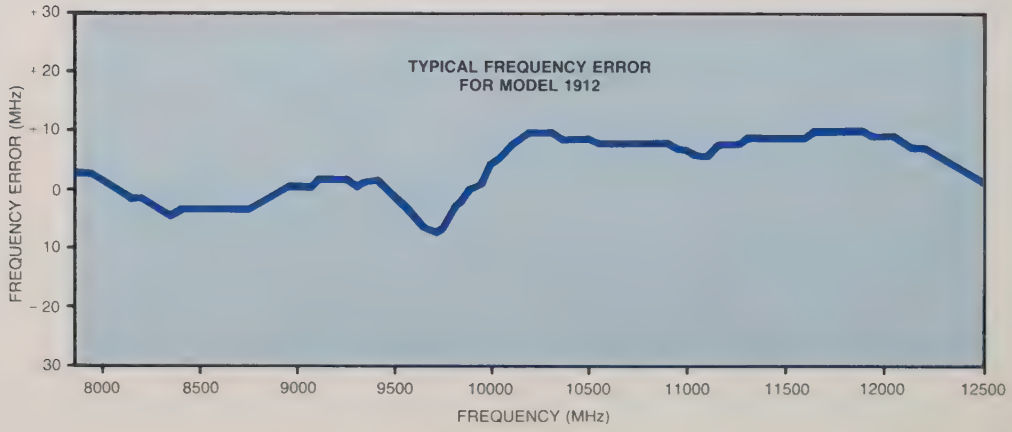
Non-harmonic spurious (all models): −50 dBc.

PHASELOCK CHARACTERISTICS (15 to 35°C)

Short term accuracy: $\leq 1.0 \times 10^{-6}$

Phase noise: −74 dBc at 100 kHz offset

Phaselock not available on models 1918 and 1926



PERFORMANCE AND PRICE FOR ANY APPLICATION.

Systron Donner's 1900 Series of sweep generators provide sophisticated, economical solutions for both production and R&D testing applications. Swept output frequency capability and synthesizer accuracy are featured in five programmable single-band instruments covering standard bands from 2 to 26.5 GHz. For straddle-band applications, the 1910 covers 2 to 8 GHz. Custom frequency ranges are available for special applications.

Housed in a standard 5.25" half-rack package, the 1900 Series features a single-YIG architecture that provides the desired frequency range without the cost associated with driving additional oscillators. Full-function, sophisticated features make these sweepers extremely versatile. Resolution for all frequency parameters is 1 MHz. All models have Start-Stop, Center-Delta, and external sweep capability as well as CW output. The sweep may be triggered automatically, manually, externally or via the AC line. The RF signal may be amplitude and frequency modulated by external signal sources. Five fully independent marker frequencies are available. Additional functions include a voltage proportional to the output frequency; penlift and blanking signals; a buffered ramp output; and input which permits a temporary sweep halt on command.

User choice leveling.

The RF output may be controlled manually or with external leveling. Internal leveling is optional on all models. When the necessary leveling components are already available to the user, internal leveling is not required, resulting in significant savings for the user. External leveling is also more accurate in situations where the device under test is more than a few inches from the sweeper.

Designed for long life.

Thermal modeling and conservative design practices have resulted in a reliable sweeper designed to meet or exceed MIL-T-28800 for Type 3, Class 5 instruments. Even at 26 GHz the internal temperature rise is less than 5 degrees C when 33.5 cfm of air is available for the cooling fan. Worst case rise is less than 10 degrees C even if the fan fails or the ambient exceeds the maximum operating temperature.

Synthesizer accuracy in a full sweep generator.

For the first time in this price range, CW frequency is effectively that of a synthesizer. CW frequencies can be phase locked with a resolution of 100 MHz. The spectral purity of the RF output often exceeds that of the finest synthesizers. Single sideband phase noise at an offset of 100 kHz is typically below 90 dBc.

Easy-to-use remote control interface.

The optional IEEE-488 interface permits remote control of all instrument functions except AC power on-off switching. To speed the development of control software, the interface responds to a native language using English words which correspond to the front panel controls. An alternate command set is provided to permit more compact programming, and keywords from each set may be mixed as desired. Additional features include the Local Lockout and Talk Only functions.

LEVELING

LEVEL ACCURACY

All except 1926: ±1.5 dB
1926 <26 GHz: ±3.0 dB, 15 to 35°C
1926 ≥26 GHz: ±5.0 dB, 15 to 35°C

LEVEL FLATNESS (15 to 35°C)

Model	Typical (dB PP)	Maximum (dB PP)
1904	0.3	1.0
1908	0.4	1.2
1910	0.6	1.5
1912	0.6	1.8
1918	0.9	2.0
1926 <26 GHz	1.5	3.0
≥26 GHz	2.0	5.0

Measured in internal ALC mode at +5.0 dBm. Excludes overshoot due to RF muting during retrace.

RF OUTPUT

Minimum output: +5.0 dBm; typically +13 dBm to +35°C
Range: −15.0 dBm to +5.0 dBm
Resolution: 0.05 dB (output), 0.1 dB (display)

SWEEP CHARACTERISTICS

Sweep Types: Internal, External

Sweep Modes: Start-Stop, Center-Delta

Trigger Modes: Internal recurrent (automatic), internal AC line, manual, external

Sweep Time Range: <0.020 seconds to >20.000 seconds; 0.010 seconds nominal minimum

Sweep Time Resolution: 0.005 seconds

Retrace Period: <10 mS, fixed duration

FREQUENCY MARKERS

Number of Markers: 5, may be individually set anywhere within instrument range

Marker Setpoint Accuracy

Model	Accuracy (MHz)
1904	±10
1908	±10
1910	±15
1912	±15
1918	±25
1926	±40

Markers within the sweep span may be individually made inactive or active as desired. Those lying outside the sweep span become active automatically when moved within the sweep.

MODULATION CHARACTERISTICS

EXTERNAL AM*

Range: ±13 dB for levels from −10 dBm to +5 dBm. Usable to the maximum available output level.

Bandwidth: ±3 dB, DC to 25 kHz; usable to 200 kHz

Scaling: +1.0 dB/volt nominal

EXTERNAL FM

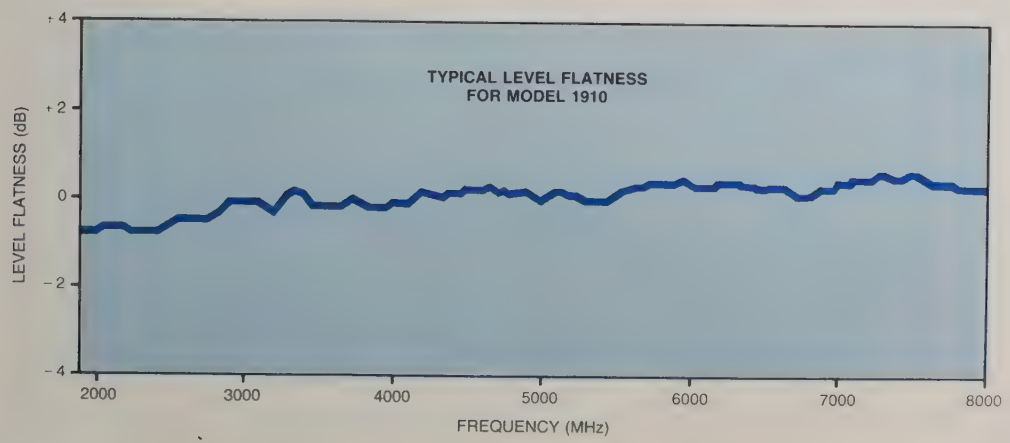
Maximum deviation: ±25 MHz for FM rates to 100 kHz; ±5 MHz for FM rates to 250 kHz. ±40 MHz is typically available

Bandwidth: ±3 dB, DC to 250 kHz, usable to >1.5 MHz

Scaling: −6.0 MHz/volt (nominal)

The external FM input may also be used to phase-lock the instrument.

*Requires internal ALC.



ADDITIONAL INPUTS AND OUTPUTS

External ALC Input: Allows remote leveling of the sweeper's RF output by an external directional detector having a coupling factor of −10 to −16 dB. May be user-calibrated so that the front panel display indicates the power at the point of leveling.

External Trigger Input: Permits external triggering of an internal sweep by a CMOS, HCMOS, or TTL signal. Switch selectable positive or negative slope.

V (F) Output: Provides a voltage proportional to the output frequency exclusive of FM modulation. Scaled to +1 V/GHz for most units, +0.5 V/GHz for Model 1926.

Ramp Output: Provides a 0V to 10V linear analog ramp synchronous with and proportional to the completed portion of an internal sweep.

Ramp Input: Permits use of an external 0V to 10V signal to control the swept frequency. The external signal is controlled by the instrument's sweep controls.

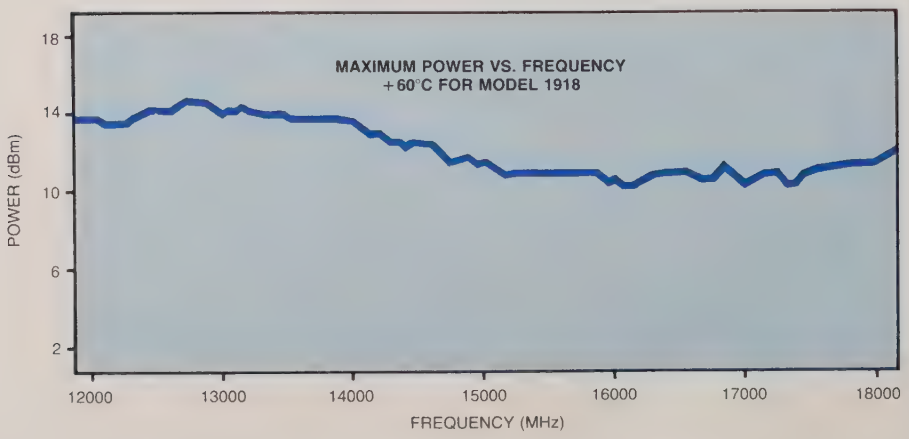
Marker Output: Produces a 1 mS pulse for each marker during an internal sweep. Selectable CMOS/HCMOS/TTL compatible logic pulse, or a pulse with limits of +4.5V or 0V, −4.5V or −13.5V.

Sweep Halt Input: Used to halt an ongoing internal sweep or to prevent initiation of an internal sweep. Frequency drift during sweep halt is typically <1 MHz/second.

NZ Blanking Output: Produces a negative-going pulse during sweep retrace period. The output is a pulse with limits of +4.5V or 0V, −4.5V or −13.5V.

Penlift Output: Produces a CMOS/HCMOS/TTL compatible positive-going pulse during the 10 mS sweep retrace period.

CHIO Input: Used with Option 06 only. As an output, provides a 27.8 kHz reference signal which modulates the RF output. May also be used as an input for an external CMOS/HCMOS/TTL signal to modulate the RF output.



GENERAL

Operating Temperature: 0°C to +50°C. Typically usable to +60°C.

Storage Temperature: −40°C to +70°C.

Dimensions: 5.75″ H x 8.38″ W x 21.75″ D (146 x 213 x 553 mm)

Weight: 26 lbs. (11.8 kg)

AC Power requirements

Line voltage: 100, 115, 220 or 240 VAC, −10% +5%

Line frequency range: <47.5 Hz to >63 Hz

Grounding: AC power source may be grounded on either or neither side of line

Power cord: U.S. standard 3-wire grounding or selected international types

Power Dissipation

Model	Typical (W)	Maximum (W)
1904	40	55
1908	50	65
1910	60	70
1912	60	75
1918	65	80
1926	75	95

Output Connector: Units to 18 GHz: Precision type N
Model 1926: SMA-compatible 3.5 mm
Front panel only

OPTIONS

02 Internal ALC: Adds internal ALC capability and eliminates the manual level adjust mode.

03 IEEE-488-1978: Permits remote control of all functions except AC on/off.

05 Special Calibration: Instrument frequency and level errors tested and minimized for operation over temperature. Requires Options 02 and 03.

06 Internal Modulator: Adds internal 27.8 kHz square-wave source to modulate the RF output. This option invalidates RF level specifications.

Specifications are subject to change without notice.

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